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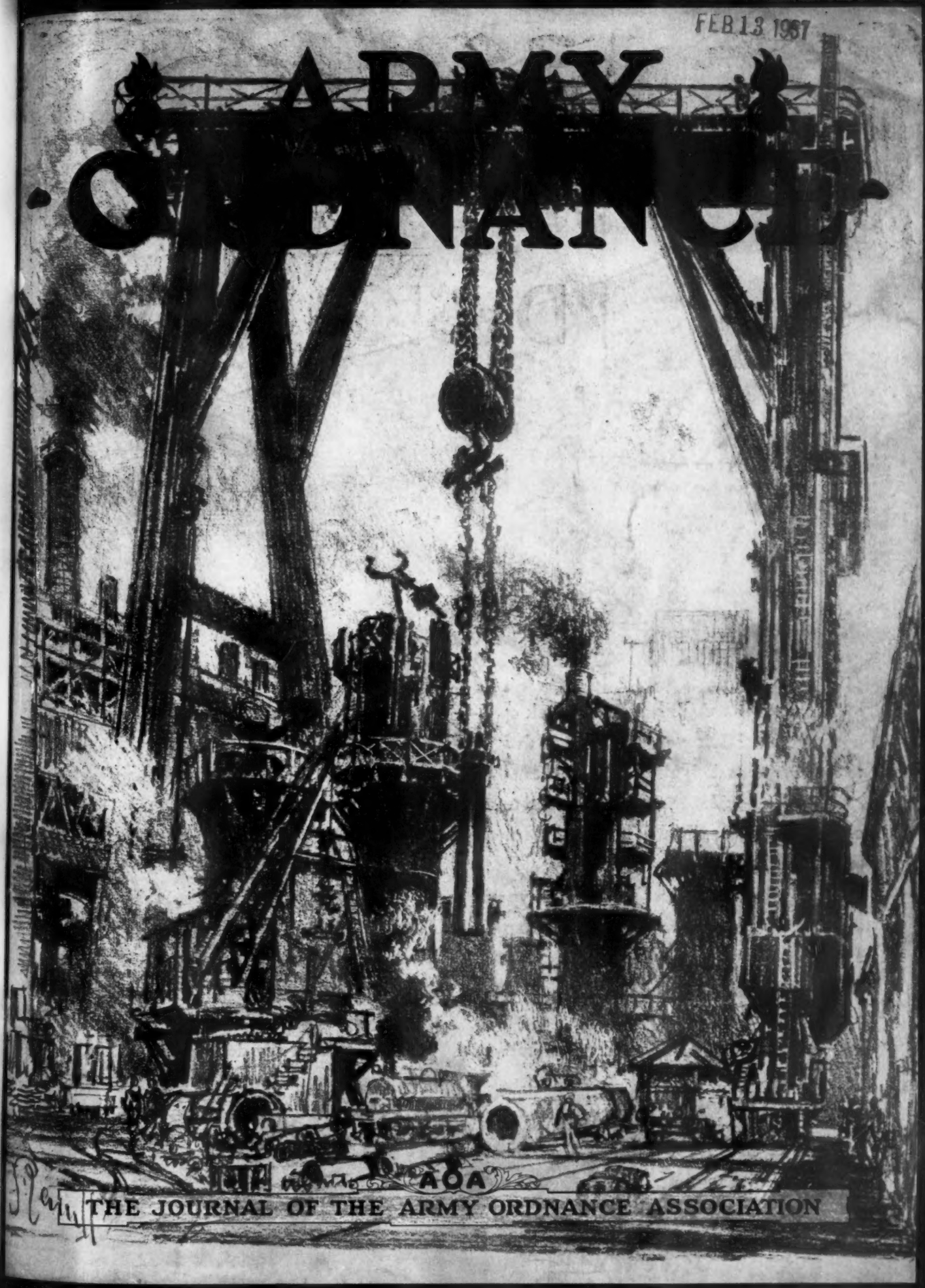

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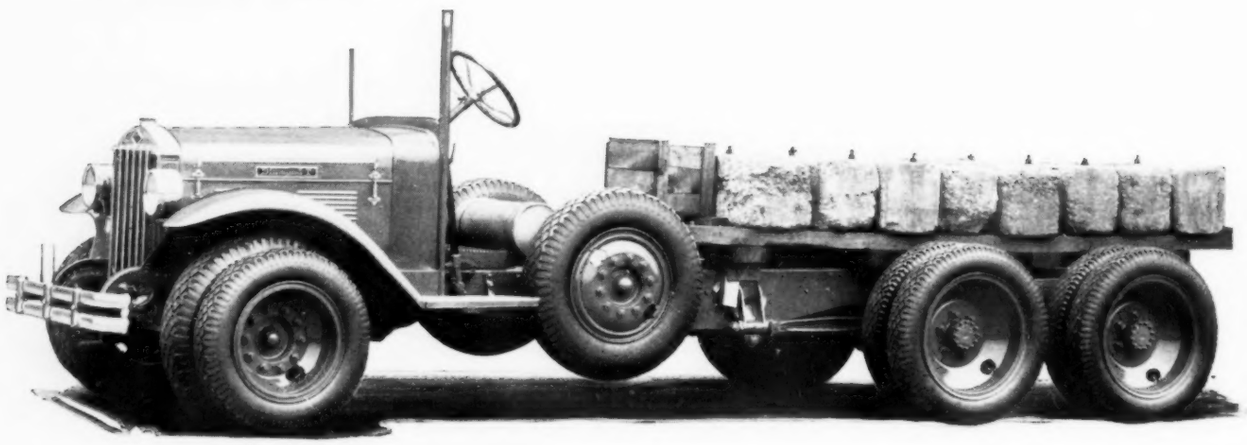

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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"The industrial war plan must conform to the living body of industry—to its customs, practices, organization and character. No human mind can grasp every detail. It can only be developed by years of labor and research. Occupying the space between the continuously changing body of industry and the intermittently changing war plan, it must slowly shape itself to each."

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Assistant to the Chief of Ordnance and
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ARMY ORDNANCE

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The Mechanization of War

Is It Necessary? Will It Last? What Will It Lead To?

By Maj. Gen. J. F. C. Fuller,* C.B., C.B.E., D.S.O.

MECHANIZATION is as old as weapon-waged war itself, and we know that so complex a weapon as the bow and arrow was known to the prehistoric hunter-artists in the South of France and in Cantabria as long ago as the tenth millennium B. C. I mention this fact because there is a tendency today to look upon the mechanization of warfare as something new. "Is it necessary? Will it last? What will it lead to?" are questions continually asked by the few who take any interest in this subject.

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Major General Fuller.

The surest and most certain foundation to the answers of these questions, and many others like them, is not to speculate on future possibilities, but to examine the past and to discover the tendencies of military evolution, which in the tactical sphere revolves around three elements or components namely, protection, movement and offensive power. These are as patent to a modern battleship, or army, as they are to a primitive savage fighting with his feet, fists and teeth. If history be examined, and in past history lies the bulk of future knowledge, a law of military development may be discovered, which is: That fighting forces adapt themselves to the environment of civilization, and must change as it changes in order to remain fitted for war. Evolution may be slow, but, in spite of the stupidity of man, it is sure and certain.

From this law, as it impinges on the instinct of self-preservation, may be deduced a principle *of vital importance*. This principle I will call "the constant tactical factor," and it is this: Every improvement in weapon-power has aimed at lessening terror and danger on one side by increasing them on the other; consequently, there is always the evolutionary pendulum of weapon-power slowly or rapidly, swinging from the offensive to the protective and back again in harmony with the speed of civil progress; each swing in a measurable degree eliminating danger. Thus, in the days of the stone age, when progress stood almost at a standstill, weapon development was proportionately slow, and may be said to have been always up to date; today conditions are diametrically reversed, civil progress being so intense that there is not only a danger but a certainty that no army can in the full sense be kept up to date. This means that in war time evolution will be extremely rapid, and, consequently, that the army which is mentally better prepared to meet tactical changes will possess an enormous advantage over all others.

For thousands of years the constant tactical factor has unconsciously urged man to adopt the missile weapon, and to protect himself against it. "Range and yet more range," is its unheard whisper, and "Protection and yet more protection," the silent echo which reverberates back. History supports this contention, and if the Classical and Christian ages of war be examined, it can be shown that each passed through three tactical cycles, namely, the cut and thrust cycle (the seeking of hand-to-hand fighting), the cut and thrust plus projectile cycle, and the projectile cycle (the avoidance of hand-to-hand fighting). During the Christian age the arm which represented the first was cavalry, the second—infantry, and the third—artillery, and by artillery I mean all projectile-throwing weapons which require a team of men to work them, such as the field gun or the machine gun. Each of these cycles passes through three stages of development, namely, germination, experimental

*In command of 14th Infantry Brigade, 5th Division, British Army, Catterick Camp, England.

evolution and full growth, which is always followed by a decline immediately the next cycle begins to uncoil itself. Thus the present infantry cycle finds its origins in the Crusades, enters its experimental evolution in the fourteenth century, and completes it by about the year 1700. Meanwhile the artillery cycle, the cycle in which fighting forces are now moving, finds its origins in the fourteenth century, enters its period of experimental evolution about 1750, rapidly evolves after 1850, and today is nearing its full growth.

WHAT is the mainspring of this tactical clock? The so-called progress of civilization, or better worded—wealth. During both ages, the Classical and Christian, we find all weapon evolution coming from the cities. The burgher and the townsman rely on craft and cunning, and with it they meet the brawn and courage of noble and peasant. On the one side we have an industrial culture, on the other an agricultural one. Directly the cities become wealthy, projectile weapons abound. Tyre, Carthage and Syracuse, all wealthy cities, rely on the catapult and balista. Once Alexander the Great has released the hoarded gold of Persia an industrialized era follows, and in such cities as Alexandria progress in weapon manufacture is phenominal. The same applies to Rome once she has obtained control of the eastern corn markets and centers of exchange. In the Christian age it is the same: the growing wealth of the thirteenth century leads to the adoption of firearms, and the gold and silver seized by Clive in India finances the industrial revolution in England, which is soon followed by a phenominal series of weapon inventions. These are not even yet near an end. It is but history repeating itself, but with this difference, that that whilst in the Classical age increase in projectile-throwing weapons eventually led to a tactical decadence on account of a lack of offensive mobility, today steam-power has prevented this in naval warfare, and petrol-power is now preventing it in land warfare. At sea, when galley met galley, fighting was hand-to-hand; when sailing ship met sailing ship, tactics were based on the idea of close range bombardment with the intent to board, but today when battleship meets battleship there is no intention to board, and battles are won by bombardments at ever increasing ranges. Will not petrol-power have the same influence on armies, and will not soldiers soon abandon all idea of "boarding," and rely solely on bombardment? The constant tactical factor whispers "Yes," because the more hand-to-hand fighting recedes the less terrifying does war become to the individual man, and he is the ultimate arbiter in battle.

2. *Tactical Foundations of Mechanization*

HAND-TO-HAND fighting presupposes the frontal attack—the simplest and most primitive offensive tactics. Between infantry and infantry such attacks are no more than wrestling matches in which courage and hitting-power are the deciding factors. Between cavalry and cavalry such attacks are more often than not mere skirmishes, and rapidity of movement and cunning must be added to the above factors. But when infantry and cavalry meet infantry and cavalry warfare becomes an art, that is, an interplay and adjustment between the three tactical elements of protection, movement and offensive power, as directed by the intelligence of the general. The ultimate object of all fighting is the imposition of will; the ideal means—the giving or threatening of blows without receiving or being threatened by them. How is this arrived at? By establishing a protective base to all offensive actions. This base may be considered as a mobile fortress, which not only secures the administrative services, the stomach of an army, but also its brain—the command. From this base the offensive is launched, and to it it returns for shelter should it be unsuccessful.

Should the enemy's base be destroyed, his army will normally tumble down like a house the foundations of which have been undermined. How can this destruction be accomplished? Obviously, by removing the base, that is by a direct assault upon it; less obviously, by circumventing it and destroying the supply services and headquarters in its rear, which ultimately may bring about surrender through starvation or through paralysis of command. This second method is far the more difficult, but when successful it is also far the most economical, because it places the enemy at such a disadvantage that, more often than not, he can be totally demoralized and disorganized by a far smaller force than his own. We, therefore, arrive at this conclusion: The rear of an army is the vital, or decisive, point of attack. In order to strike at the rear, generally speaking it is not necessary only to circumvent the enemy's front but to fix it, that is to immobilize it. Once this operation is accomplished and the enemy is pinned to his position, the next step is to circumvent this fixed front and by a rapid movement strike at the vitals in rear of it. Should this be accomplished, then this front itself will crumble to pieces. Until recent years, the fixing operation was the duty of infantry, and the out-flanking operation that of cavalry.

TURNING now to history. The tactics of all the greatest masters of war, such as Alexander the Great, Hannibal, Scipio, Frederick and Napoleon have been based on this theory of "hold, move and hit." Napoleon himself said: "The whole art of war consists in a well-reasoned and extremely circumspect defensive, followed by rapid and audacious attack." When tactics have not conformed with this theory, the art of war has fallen into decay. This has been notably the case since the introduction of the breech-loading rifle.

Why has this happened? This question is an important one, and unless its answer is grasped one of the main reasons for mechanization will remain obscure.

In the days of the flintlock musket the clinch between the opposing infantry forces was an easy matter, the effective range of this weapon was less than one hundred paces. In its day cavalry could still maneuver freely and artillery be brought into line of battle. Then came the rifle bullet, and it chased the cavalry away and drove the artillery back, isolating the infantry and increasing the fighting distance between the two opposing infantry fronts. Today we find that cavalry have lost practically all their offensive power, consequently that the above theory of "hold, move and hit" has become inapplicable. The result is that the whole onus of the fight is now thrown on the infantry supported by artillery; that the frontal attack has replaced the rear attack, and that the sole object of the attack is the assault.

To assault means masses of men and masses of guns, yet to turn to the history of the last seventy years, i. e., the

period of rifle warfare, the assault has progressively become more costly and more difficult. In the American Civil War, the first of the great rifle wars, seven assaults out of every eight proved unsuccessful. In the Franco-Prussian War no frontal attack of any considerable force carried out by either side succeeded. In the British South African War bullet-power was so devastating that nearly all frontal attacks, even against the badly disciplined and poorly armed Boer, failed. In the Russo-Japanese War, the only successful operations were outflanking ones. And in the World War, after the first rush of battle had exhausted itself, so vast were the hordes[1] of foot soldiers that no flanks were left open, and each side in turn to save itself was compelled to go to earth, the spade supplementing the rifle proclaimed a stalemate. No soldier of note had clearly foreseen such a tactical deadlock, yet in 1897 M. Bloch, the eminent Polish banker, had predicted it. He then wrote:

"The war, instead of being a hand-to-hand contest, in which the combatants measure their physical and moral superiority, will become a kind of stalemate, in which, neither army being willing to get at the other, both armies will be maintained in opposition to each other, threatening the other, but never being able to deliver a final and decisive attack. . . . That is the future of war—not fighting, but famine, not the slaying of men, but the bankruptcy of nations and the breakup of the whole social organization. . . . Everyone will be entrenched in the next war. It will be a great war of entrenchments. The spade will be as indispensable to a soldier as his rifle. . . . All wars will of necessity partake of the character of siege operations. . . . Your soldiers may fight as they please; the ultimate decision is in the hands of famine."

3. *Growth of Mechanization during the World War*

THE war opened with the old infantry idea of the assault. The great German armies, it was thought, by sheer weight of numbers would, like an inflowing tide, sweep all before them. The French armies trained on the theory of the *offensive à outrance* were to cut this gigantic German phalanx in half, and destroy it as Alexander the Great had destroyed the hordes of Darius. Nevertheless, every tactical idea was soon proved to be bankrupt, and the autumn and winter of 1914 saw the bursting of the most gigantic military South Sea Bubble which the history of war hears record of. The rifle and the bayonet having failed in the attack, willy-nilly the constant tactical factor compelled the belligerents to seek more powerful weapons, and they turned to the machine gun and the cannon. To those who could see what was really taking place, the infantry cycle of warfare, which had so long been in a decline, finally unwound itself into the artillery cycle, and it is with artillery that war is now made. In 1915, a new tactical theory was propounded, it was: "Artillery conquers and infantry occupies." The following year we see infantry playing the rôle of supporting troops to artillery barrages; they do not fight in the ordinary sense of the word, but merely move forward. If the barrage succeeds they occupy the enemy's position, if it fails they fail, in both cases their casualties are terrific.

The great artillery battles of 1916 and 1917 in France gave an enormous stimulus to motorization, which is the beginning of mechanization, which in its modern sense may be defined as motorization armored. For example: In the Third Battle of Ypres which took place during the summer and autumn of 1917, the British fired 4,283,550 shells costing £22,000,000 in the preliminary bombardments *before the battle opened*. This number of shells represents 107,000 tons which translated into terms of transportation means: 27 four-thousand ton ship-loads; 540 four-hundred ton train-loads (in England and France) and 35,666 three-ton lorry-loads. Without these lorries such battles as this one, and the battle of the Somme and Verdun in 1916, would have been impossible. In 1914, when war was declared there were a few dozen mechanical vehicles in the British Army, when the war closed in November 1918, there were 119,372.

IN spite of shell-power and motorization, the great artillery battles were a grim and costly failure. The answer to the tactical stalemate had been sought in tonnage of projeciles, but its true answer was to be found in surprise and the maintenance of forward movement. Not only was surprise wanting in these battles, but the destruction of the forward areas and their communications by the bombardments themselves rendered an advance across the cratered zone all but impossible. In fact these battles defeated their object, and had no other means of waging war been discovered and had it been possible for the belligerents to endure their losses and the financial strain, the war might well have lasted a hundred years.

This, however, was not to be, for the constant tactical factor, in spite of all stupidity, compelled men to consider other means. Lethal gas was tried as a projectile. There was nothing new in this idea, but its apparent novelty shocked humanity, in spite of the fact that it was twelve times as humane as bullets and shells. Of gas casualties in the American Army only 1.87 percent resulted in death, whilst in casualties from bullets and shell fire 23.4 percent proved fatal.

The second attempt was a totally different one, it was not to discover a new or more powerful offensive weapon, but to deny power to the most formidable of existing ones —the rifle and machine gun bullet. It was obvious that half an inch of steel plate was the answer to the bullet, but the difficulty was to carry it. The soldier could not do so, therefore, a machine which could move across country had to be invented. In the British Army this machine was called the "tank," a machine which combined within itself the three tactical elements, namely, protection, movement and offensive power in an intimate relationship.

The introduction of the tank was the necessary consequent of the stalemate, and as steam-power produced the armored battleship so now did petrol-power produce the armored fighting vehicle. On March 9, 1862 when the *Merrimac* met the *Monitor,* the then accepted theory of naval warfare was completely shattered, and in England Sir John Hay said: "The man who goes into action in a wooden ship is a fool, and the man who sends him there is a villain." The same with justice might have been said after the first tank action on September 15, 1916, with the words "woolen coat" being substituted for "wooden ship."

[1]The size of armies during the second half of the nineteenth century was almost entirely due to the railway as a means of supply.

The great tank battles which followed, such as the battle of Cambrai, on November 20, 1917, and that of Amiens, on August 8 the following year, can only be described as revolutionary, and this in spite of the crudeness and imperfections of the machines. According to Marshal von Hindenburg, August 8 was the "black day" of the German Army, and according to General von Zwehl, "We were not defeated by the genius of General Foch, but by General Tank."

THE details of the great tank battles do not concern us here, but a comparison between those engagements and the great artillery battles which preceded them is instructive, as it clearly shows the values of two schools of thought —the armored and unarmored schools of tactics. I will now examine this question under five general headings:

(1) *Fighting Man-Power.* A field gun requires 14 men to work it, a machine gun 6, a trench mortar 5, and a tank machine gun 1.3. If in place units be taken, then these figures will read as follows: 32.6 men per gun in an artillery brigade of 24 guns; 14.5 men per machine gun in a machine gun battalion; 6.2 men per trench mortar in a trench mortar battery, and 3.07 men per machine gun, or cannon, in a tank battalion.

As regards casualties the comparisons are amazing. On the first day of the battle of the Somme, July 1, 1916, when no tanks were used, the British casualties were approximately 60,000. On the first day of the battle of Amiens, August 8, 1918, when 415 tanks were used, they were slightly under 1,000. Between July and November 1916, British casualties per square mile of battlefield gained were 5,300; during the same months in 1917, at the Third Battle of Ypres, they were 8,200; and during the same period in 1918 they were 83. In the third period alone were tanks used in numbers and efficiently.

As regards percentages of killed and died, wounded, missing and prisoners to total casualties of each arm the following British figures speak for themselves:

Arm.	Killed and Died.	Wounded.	Missing and Prisoners.
Cavalry	23.33	66.35	10.32
Artillery	20.37	75.71	3.92
Engineers	20.35	72.46	7.19
Infantry	19.96	64.23	14.81
M. G. Corps	17.27	66.30	16.43
Tank Corps	12.58	70.24	17.18
Other Arms	27.39	65.67	6.94

(2) *Manufacturing Man-Power.* The 4,283,550 shells fired in the preliminary bombardment at the Third Battle of Ypres represent 176,000,000 man-hours at 2/6 an hour. On the first day of the battle of Cambrai 378 tanks were used and 293,149 shells were fired. The cost of a tank was then approximately £5,000 and of a shell £5. Though only 48 tanks were hit on this day I will suppose that all were lost: then the total cost in tanks and shells was £3,350,000 and not £22,000,000; the saving was, therefore, £18,650,000 or 149,200,000 man-hours, that is 49,400 men working for 300 days at 10 hours a day at 2/6 an hour. It might be noted here that 49,400 men represent the personnel of 67 tank battalions; at the battle of Cambrai 9 were used.

(3) *Expenditure of Money.* Economy in man-power is an enormous economy in money, nevertheless I will take a more concrete case. From the above it will be seen that the cost of one tank was equivalent to that of 1,000 shells. A shell once fired is totally expended, a tank, accepting a very conservative reckoning, will fight four engagements before being wrecked; therefore the case of one tank is approximately equivalent to that of 250 shells. Consequently, had the cost of the 4,283,550 shells fired at Ypres been spent on tanks, 17,134 machines could have been produced. At the battle of Amiens, only 415 of these machines were used, and with decisive results.

To turn now to the expenditure of the British Ministry of Munitions during 1917-1918. The total figure given is £672,164,933, which is divided into twelve categories. Of these by far the smallest item quoted is for tanks, the cost of which was £9,587,960; transport vehicles alone cost four times this sum.

(4) *Economy in Transport.* I have already quoted the tonnage and the transport required to move the 107,000 tons of shells expended in the preliminary bombardment at Ypres. When compared to this battle, the saving in tonnage for shells at Cambrai was 401,269 tons (in shipping, rail and lorry moves), and if 100,000 tons be deducted for the 378 tanks used on November 20, 1917, a very liberal allowance, a net saving of 300,000 tons is the result.

As regards petrol consumption: For all petrol-driven vehicles the following figures are exceptionally instructive. The largest item shipped to France was not shells and ammunition, which totalled 5,500,000 tons, but hay and oats, which totalled 6,000,000 tons, and which exceeded the petrol burnt by all motor vehicles, tanks and aircraft in France by well over 5,000,000 tons. If to these 6,000,000 tons of forage be added the shipping required for forage in other theatres of war, and to transport the 1,500,000 horses overseas which were transported, the tonnage required by horses and their forage was approximately equivalent to the total tonnage of British shipping sunk by German submarines during the war.

(5) *Economy in Time.* I will now show, from the military point of view, that the tank is a time economizer, and as an example I will compare the operations of the summer of 1917 with those of 1918. At the Third Battle of Ypres, between July 31 and November 14, 1917, an advance of about 12,000 yards was made; the average daily penetration was, therefore, 110 yards. Between August 8 and November 11, 1918, an advance of over 60 miles was effected, consequently, the average daily penetration was 1,100 yards. During the first of these periods the use of tanks was limited, during the second they were used in the van of nearly every attack, and the result was that the military hour was reduced to six minutes; in other words, ten times more work was done in the hour when tanks were used than when they were not.

Most of the above figures have been taken from "The Statistical Abstract of the (British) Armies at Home and Abroad" published in 1920, and may be accepted as accurate. They speak for themselves, and show the enormous influence and importance of motorization and mechanization during the war. Had the war continued for another year, there can be little doubt that the world would have seen the launching into battle of veritable tank armies, and this is shown by the fact that the British program for the spring campaign of 1919 was to include 8,000 tanks and 10,000 cross-country tractors among its items of supply.

4. *Present Development of Mechanization.*

THE above statistics and all they imply were at the time quite unrealized by soldiers and, astonishing to relate, to most they remain so. In the summer of 1918, the only three eminent men who in any way considered this question of fighting values were Marshal Foch, Field Marshal Sir Henry Wilson, and Mr. Churchill, the British Minister of Munitions. The result was that the 1919 plan of campaign was to be founded on the tank. Though, during the war, for purposes of attack, the infantry had proved themselves to be impotent, and the artillery ineffective, so conservative is the military spirit that no sooner had the last shot been fired than the experiences and terrors of four years of devastating war vanished like a morning mist, and a general proclamation was made that "now we can get back to real soldiering." We are apt to wonder why the chivalry of France throughout the Hundred Years' War, and in spite of defeat after defeat, continued to charge the English archers; yet in the twentieth century we think it in no way peculiar to emulate them. Before 1918 was out all armies had got back to the infantry idea in tactics, and prolonged conversations were held on the advantages and disadvantages of the long and the short bayonet.

The years which have followed the war have been years of military lethargy and coma. This is to a certain extent inevitable after a great war, because, for the time being, the object of war vanishes, and money being short every advantage is taken of this fact to sink back into the peaceful quietude of pre-war routine. Except for the church, no human organization is so conservative as an army.

Yet the changes which, during the last thirteen years, have taken place in civil life have had a pronounced, though largely unconscious, influence on the development of military power. It may be said, that since the opening of the present century the civilized world has experienced a second industrial revolution due to oil and petrol. The ever-increasing numbers of motor cars, lorries and other mechanically propelled conveyances are rapidly eradicating the horse in all industrial countries; consequently the supply of horses for war is growing less and less. Not only are mechanically-propelled vehicles exterminating man's best friend in the old agricultural world, but they are also pronouncedly influencing man himself. He is ceasing to be a walking animal, and this fact is already seriously affecting the recruitment for infantry units in all long service armies. Few men want to be infantry, and who can blame them; in peace time they must march with 56 pounds on their backs through heat and storm, and in war time they are mere tank-fodder. On April 24, 1918, seven British tanks manned by 21 officers and men in all, overran three German battalions and slaughtered over 400 of their men. This is not war, this is massacre.

SUCH progress in mechanization as has taken place since the close of the war has been entirely due to the progress of civilization, backed by the efforts of a few clear-sighted enthusiasts who have been dubbed mad, because they realized what was taking place in the civil world outside them. This world is a sealed, if not an heretical, book to the military monasteries. Progress has been made, and is being made, but it is the progress of chaos out of which in the future a new military cosmos will be created. It is the costly process of nature, of trial and error, and not the economical process of reasoning man. Machine guns are in ever-increasing numbers added to armies in order to obtain more fire-power, when the true problem is not to increase it but to restrict it by armor. The fire-power of an infantry division today is approximately ten times what it was in 1914, and yet the tactical schools still think in terms of the assault. Motorized vehicles are being pushed into marching organizations when it should be obvious to a child that such a mixture of varying degrees of mobility can only end in confusion worse confounded. The trouble is that the tactical idea remains the assault, and that consequently the infantry idea obliterates all other ideas and darkens the path of progress. All other arms are but auxiliaries to the man on foot; they must fit in somehow as best they can; but the supremacy of the foot soldier must not be doubted, for he is still the jealous god of the battlefield. When armies get back to the idea of "hold, move and hit," to a correct equation between protective and offensive power as related by movement, then will this dismal bolgia in which they are sunk receive its first ray of rational sunshine. If armies went to war today, the confusion and loss of life would be catastrophic. Within three weeks of the war opening, there would be two stupendous military operations in full play. We should see the regular forces digging like beavers, and circling around them would be seen tens of thousands of motor cars, some carrying soldiers and some civilians armed with rifles, machine guns and explosives. There would in fact be two wars—a regular war stopped short, foundered in the bullet zone, and a motorized guerilla war in which each guerilla army would attempt to sting to death the immobile saurian which lay bogged before it. It would be a war of motor cars, later on it would be a war of tanks.

FOR such a war, where are the most skilful soldiers to be found? Not on the drill square or in the barrack room but in the machine shop and the garage. The great hordes of unwilling infantry which today crowd European armies, will be as impotent against these men, men who can drive and repair, men born of the machine and possessed by the machine sense, as Crassus—he of the First Triumvirate—was at Carrae when the Parthian horsemen surged around him.

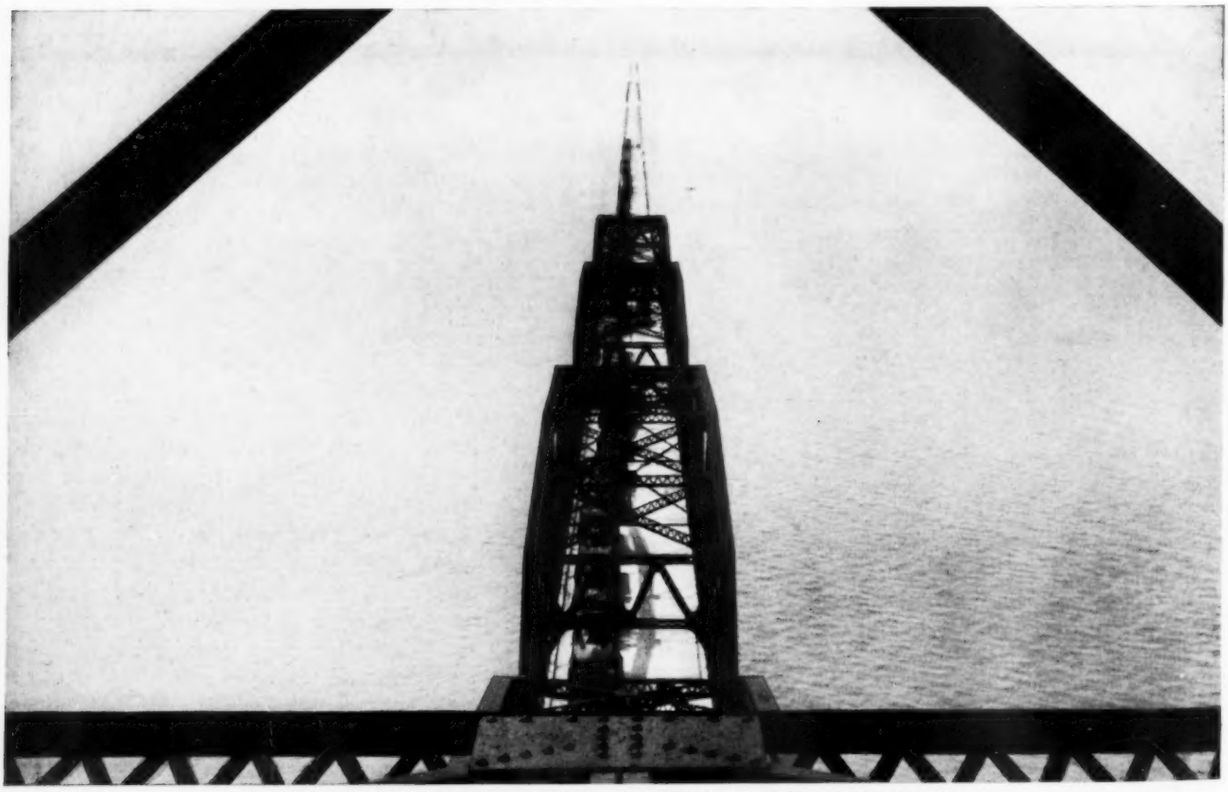
As warfare becomes more specialized and scientific, so will it be realized that conscription is the poorest method of recruitment for the *combatant* arms. I do not say that conscription will altogether die out, because once an enemy has been defeated the zone of country won will have to be occupied and policed, not by highly trained soldiers but by partially trained militias. When, in 1919, the victorious allied powers compelled Germany by a military clause in the Treaty of Versailles to maintain a small professional army in place of a conscript one, they laid the foundations of future German military power. Whilst France, who has insisted on maintaining her great conscript horde, has in the military sense emasculated herself.

Thus far, the more obvious consequents of mechanization on military power; but there are others of a deeper nature, and these must also be grasped if its influence on the future of war is to be understood. *(To be concluded in the next, the March-April, 1931, issue of this Journal.)*

Machines of Warfare in Realistic Outline

Uncle Sam Stages a Battle Against his own Outworn Planes.

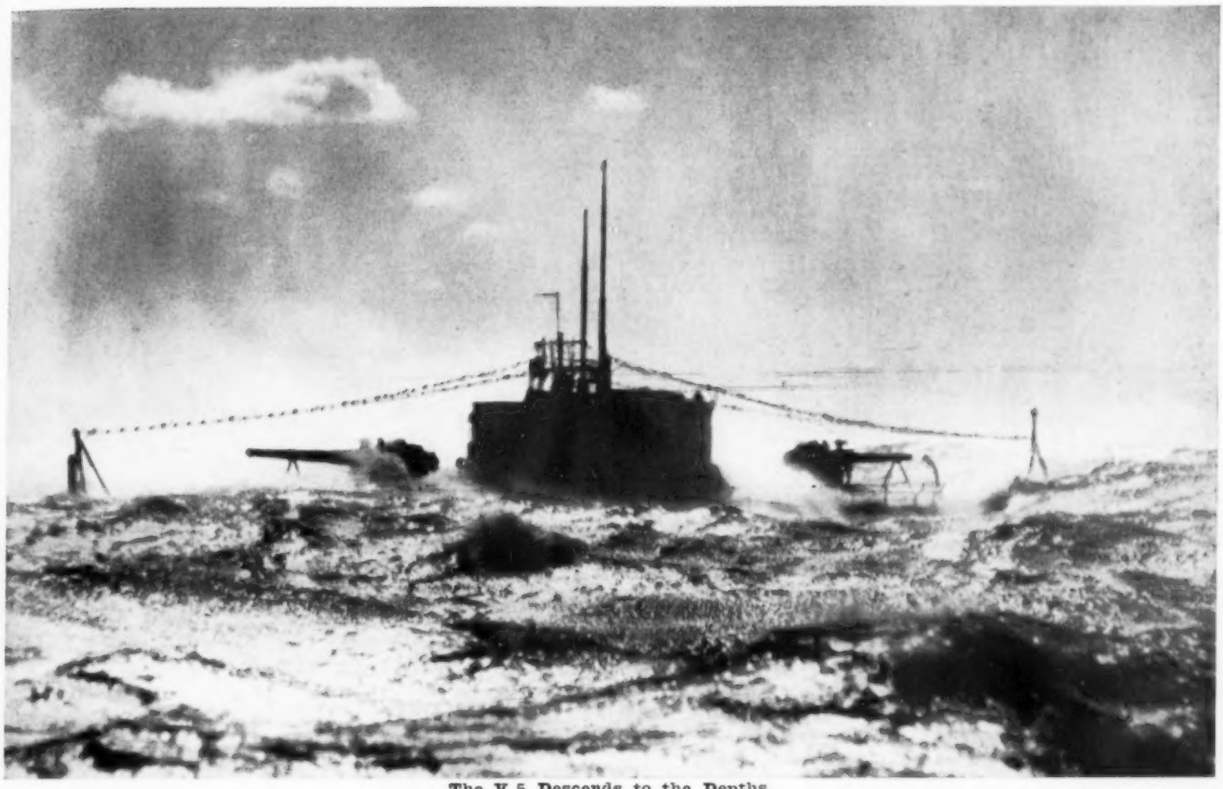
This photograph, taken during recent bombing tests at Camp Stanley, Texas, shows a group of obsolete planes being attacked by modern bombers. The tests were to determine the effects of bombs upon aircraft.



The Army Goes to Sea—Over the Longest Highway Bridge in the World.

A miniature army of 65 trucks as it appeared from the superstructure of the 4½-mile long James River bridge, near Norfolk, Virginia. Thirty of the trucks carry light tanks on an extended march across land and water.

The Latest Submarine Addition to the U. S. Navy



The V-5 Descends to the Depths.
With her guns awash the V-5, the American Navy's largest undersea craft, submerges to calmer seas. The photograph was taken during recent "shakedown" tests off Provincetown, Mass.

The V-5 Returns to the Surface.
Full speed ahead and the Navy's newest submarine passes the U. S. S. Falcon ploughing through heavy seas off the New England coast. This photograph also was taken during trial tests of the new craft.

National Strategy of the United States

Are Our Defense Policies Suited to Our Probable Needs?

By Hoffman Nickerson*

THERE is a true saying quoted by Foch from Von der Goltz and recently requoted by that keen English student of war, Admiral Sir Herbert Richmond, in his "National Policy and Naval Strength" as follows: "Whoever writes on strategy or tactics should limit himself to teaching national tactics, for no other can be profitable to the nation he is addressing." Foch, in his "Principles of War," goes on to say that were he speaking not in Paris but in Brussels his teaching would bear particularly on one form of war with a single definite aim: to delay as much as possible the progress of an invading neighbor until the forces of other powerful neighbors can come up in defense of Belgium's violated neutrality. Thus Belgian conditions impose upon the Belgian army the task of avoiding decisive engagement, of postponing the decision. Again in London different conditions and therefore different purposes are found: an insular position to be maintained, colonies overseas to be maintained and developed. Accordingly British strategy must be essentially maritime and Britain requires of her land forces only small positive results in colonial theatres, and near home the all-important negative result of maintaining her naval position—chiefly by preventing any great power from unifying against her the continental coast of the Narrow Seas. Again in Madrid political and financial conditions, the geographical position and the nature of the Pyrenean frontier, forbid the idea of European conquests and Spain therefore expects of her army simply the preservation of her territory. The Marshal might have gone on to say that when France and Germany were the two chief military powers of Europe, how to deal with the other's army was the chief problem of both. And so on for any other nation.

That is to say, the principles of war, whatever they are thought to be and however absolutely they are conceived, must always be applied to specific cases arising from the material and moral characteristics of the human groups involved. For war which is the attempt by one human group to assert or maintain its will as against another is like all human things a blending of the material and moral.

What then are the elements of United States' national strategy?

THE United States, now the richest nation in the world and in which the individuals enjoy the highest standard of material comfort of any people on the planet, constitute a group of about one hundred and twenty million souls inhabiting a continental block of territory roughly rectangular in shape and consisting of about three million square miles. The northern and southern boundaries of this rectangle are each about two thousand miles long; beyond the northern boundary lies Canada, beyond the western half of the southern boundary, Mexico. The remaining eastern half of the southern boundary is formed by the Gulf of Mexico; the eastern and western sides of the rectangle, each—very roughly—of about a thousand miles, are the coasts of the Atlantic and Pacific oceans. Besides this continental block the United States possess certain outlying territories which fall into three main groups; first the Panama Canal Zone together with certain Caribbean Islands strategically subordinate to the Zone, second the Hawaiian Islands and third the Philippines with their stepping stone, Guam. These transmarine territories are negligible in population and area and although they modify profoundly the national military problem their strategic interest is merely that of their usefulness for the purposes of the vast continental block.

The land neighbors of the United States are comparatively insignificant in point of population; Mexico has only eleven per cent and Canada only five per cent of our numbers. In both the actual wealth is considerable and the potential wealth enormous. The population of both contains excellent raw material for soldiers; the Mexican with his Spanish and Indian blood is inured to hardship and of an astonishing natural courage; the performance of the Canadian Expeditionary Forces against Germany will not soon be forgotten. On the other hand, neither country is firmly organized for war and both suffer from internal division. Mexico has had a series of revolutions together with a recent and bitter religious quarrel. Canada is homogeneous neither in language nor religion; there is a large and compact French-speaking minority concentrated in the eastern part of the country near the St. Lawrence river and devoutly Roman Catholic in religion, whereas the majority of the people is of the Protestant culture and speaks English. It will be remembered that the cleft between these two groups limited Canada's participation in the recent war, helped to prevent conscription, etc. Although the strong emotion of defending one's country often heals such divisions it sometimes fails to do so. Furthermore both Mexico and Canada are strategically vulnerable. The chief internal communications of Canada run east and west close to the United States' northern border and would be easy to cut and her chief centers of population in her south-east and south-center lie within striking distance of corresponding centers of population and communications within the United States. Mexico imports foods and especially bread-stuffs and would therefore be easily reduced by naval blockade plus an occupation of the Mexican-American frontier and perhaps a chain of posts across the 125 miles of the Isthmus of Tehuantepec in southern Mexico. Nor is there much to be feared from the continental neighbors of the Panama Canal Zone.

As members of a coalition directed against the United States either Mexico or Canada would be of first rate importance. On the other hand, it would probably require

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the greatest provocation from us before they could be persuaded to enter such a coalition since they would be far more exposed to our attack than their partners. It will be remembered that in the famous Zimmerman note Germany proposed an alliance with Mexico and from time to time there have been rumors of an understanding between Mexico and Japan. Mexico however did not see fit to accept the German proposal and the Mexican-Japanese stories seem never to have been substantiated. Canada is of course a part of that somewhat vaguely defined confederacy known as the British Empire. Britain however possesses no overwhelming military force and even did she possess one she would be most unlikely to engage in war with the United States. The trend of her foreign policy since 1918 has been to associate herself with us as far as we have been willing to permit; so much so that it would not be altogether fantastic to say that she shows signs of falling into the orbit of the United States. In the event of a British-American war, although our position would be difficult, hers would be so desperate that her statesmen could hardly consider the possibility. Finally, even should Britain make war upon us it is by no means certain that Canada would come in on her side. Canada might declare herself neutral. In any case the comparative military weakness of our only continental neighbors makes it most unlikely that the United States will fight a first-class war on land alone. The chances are that such a war would either be chiefly naval or would be carried on amphibiously by a combined operation involving both fleets and armies.

THIS first cardinal factor of our national strategy, then is that any possible great war would certainly require effort by sea (either by us or against us) whereas it might or might not require a corresponding effort by land. Furthermore, a navy cannot be improvised. American perception of these truths has long been reflected in the high numerical rank of our war fleet among the fighting ships of the world. For nearly forty years our Navy has steadily grown both in absolute and relative strength until today we are committed to the principle of equality in material with the other chief naval power of the world, Great Britain.

The United States maintains a navy for four purposes. First to prevent invasion of the continental United States from overseas; to the chances of invasion we shall presently return. Second, to control the Caribbean together with the Pacific approaches to the Panama Canal; should the Canal be occupied or destroyed or the Caribbean entered by a hostile fleet, the United States would be gravely inconvenienced. Third, to protect our important and increasing coastwise traffic by sea. Fourth, to be strong enough to deter other naval powers from interfering unduly with American seaborne trade in future wars toward which the United States preferred to remain neutral. In this fourth case of a war to prevent what might be considered intolerable interference with American trade (and such interference might mean great distress among our people to which war would be preferable) foreign bases would be available to us in the harbors belonging to those powers whom we were joining, as the Allied harbors were open to us in 1917-18. In such future wars, however, the land troops of our foreign allies might or might not suffice to guard these bases and carry on other necessary land operations. In controlling the Caribbean and the approaches to the Canal, on the other hand, our Navy would require at least a minimum of coöperation from United States land troops.

To insist upon the comparative weakness of our continental neighbors, and therefore upon our necessity for strength by sea, is by no means to deny the necessity for land forces. In the first place, even if one were to consider future operations from the naval standpoint alone, it is clear that the fighting power of a fleet is vastly increased if the admirals are free to strike without fear of disaster, should a bold and fortunate enemy slip by them and strike at some vulnerable point during their temporary absence. And it is equally clear that armies can do many things which fleets cannot.

FOR what purposes then does the United States require land forces? First of all, a minimum of armed force is needed for an emergency police work.

Such a force may at any time be imperatively demanded to maintain internal order. Throughout their history the American people have shown high capacity for organizing emergency forces such as the Vigilance Committees. In one sense the danger is not as great as in the past for the complexity of civil life, communications of all kinds, etc., together with the corresponding complexity of modern armament, give the governments of today far more physical power over unwilling subjects than was ever formerly possessed. Nor have we at the moment much reason for fearing grave insurrection. Nevertheless all history shows the probability of occasional civil outbreaks, and in particular the world-wide quarrel between capitalist and proletarian is to some extent present among us.

Further the United States has for some time found it desirable to patrol its south-western border to prevent local injuries to its citizens arising from disturbed conditions in Mexico.

Again emergency police work has been needed in countries incapable of ordering themselves and therefore of protecting the lives and legitimate interests of Americans and other foreigners within their borders. Sometimes such action has been taken by the United States acting alone; in our Caribbean sphere of influence Haiti and Nicaragua are instances. Sometimes the United States troops have served as contingents in international armies, as in China where we still help to provide railway and legation guards. The justice and wisdom of such operations are of course never as completely self-evident as in the case of internal insurrection or border control; it is a question for statesmanship to decide in each individual case. Nevertheless instances have occurred often enough to indicate the future possibility of others.

Beside emergency police work, a minimum of land force is required as insurance against the supreme military calamity of armed invasion.

This matter of invasion requires careful statement. The continental United States, the richest of all countries, would most repay conquest. Moreover certain of our internal policies, such as our high tariff and drastic laws against immigration, are calculated to anger foreign countries; especially the barrier against Asiatic immigration must be held in arms. If our prohibition policy is maintained it may well prove a contributory irritant; it has already given rise to startling and revolutionary changes in international law.

As to the strategics of invasion it is clear that any complete occupation of our vast territory is out of the question. There remains the possibility of occupying certain areas and as to this two suggestions have been made. The first of these is based upon the fact that the center of gravity of the United States is to be found in its north-center and northeast and that much of this vital area could be covered by a line running from Lake Erie, in front of Pittsburgh and thence to Washington. Such a line would be less than 300 miles long, only about three-quarters of the western front of 1914 to 1918. An enemy who once made good this line, controlling the city populations within his occupied area through the threat of interruption to their food supply and other necessities, such as water and light, could bring about so intolerable an interference with the national life as to be able to compel peace on his own terms. Again, it has been remarked that if once the Pacific coast region could be occupied the difficulty of communication across the Rocky Mountain zone would make reconquest difficult.

On the other hand, no country in the world is less liable to invasion than the United States as long as the necessary minimum of armed strength is kept up. The mere difficulty of transporting large armed forces across great oceans is enormous. The national divisions of Europe will almost certainly remain throughout any future we can now foresee. Even during such a decade as the eighteen eighties, when the immediate naval and military powers of the United States were alike negligible, invasion was neither attempted nor even threatened. Some twenty years ago the chances of invasion across the Pacific were discussed by General Homer Lee, an American serving in the Chinese army, in a book called "The Valor of Ignorance" (Harpers, 1909), which sought to show that such an operation was possible. But even if one were altogether to admit the argument of that book as of its time of writing—which would be a somewhat generous admission—still our subsequent increase in naval and military strength and the strategic revolution in our favor, thanks to the Canal and the occupation of Hawaii, have combined against the chances of an invader.

Even in time of peace garrisons are required for the Canal, Hawaii and the Philippines, each of which if altogether uncovered would be peculiarly vulnerable in its own way. The locks of a canal are easy to injure. The population of the Hawaiian group is chiefly of non-American stock and contains a block of reservists subject to the call of a non-American power with which unhappily we have from time to time had a certain political friction, which reservists if armed would be formidable. The Philippines are inhabited by a non-American people among whom a certain desire for independence exists. They are moreover distant no less than six thousand miles from the Pacific ports of the United States.

At this point I digress for a moment to note the strategic advantages secured to the United States through the possession of the Canal and Hawaii together with the disadvantage inflicted by the possession of the Philippines. Briefly, the Canal shortens by the enormous distance of some nine thousand miles the voyage between our Atlantic and Pacific coasts. Possession of the Hawaiian group, together with the organization of a naval base there, and the absence of strong naval bases in the hands of other powers within the eastern strategic area of the North Pacific, gives the United States Navy control over that entire area. Both the Canal and Hawaii are therefore first-rate military assets. The Philippines on the contrary are geographically eccentric to the last degree from our central continental block, their reënforcement even in peace takes time and would almost certainly prove impossible in war. As against any power possessing strong bases near them the Islands would almost certainly fall, carrying down with them the ships and men assigned to their defense. Were this military disadvantage compensated by the usefulness of the Islands to some major policy of the United States, then the strategic liability might be justified. If on the other hand no such major policy exists—and it has not yet been shown that it does exist—then the consequent strategic advantage to the United States would seem good reason for withdrawing from the Islands.

To return from this digression: we have seen that the United States requires a respectable minimum of armed strength by land for emergency police work of different sorts, to increase the improbability of invasion of their home territory and to garrison outlying possessions overseas.

THERE are also contingencies of national policy which might require armed action by land as well as by sea. In this connection it is not necessary to debate the value of arbitration treaties such as the Kellogg pact but merely to point out that arbitration at any time may fail to work. In such a case the chances of war would depend upon the national aims of the United States. Except for the Monroe Doctrine the United States has defined no standing principle of foreign policy of which the violation by other nations would mean war. Moreover, since 1918 even the countries formerly possessed of far-reaching and well defined policies have so far found themselves reduced to uncertainty and vagueness through the disturbed and largely fluid state of the civilized world. All discussion of warlike contingencies must therefore limit itself to the most general terms.

First then, it is conceivable that the United States might invade a continental neighbor; within living memory many Americans have thought an invasion of Mexico might be attempted. The political motives against invading either Canada or Mexico are so strong that it is necessary only to state them; in the case of Canada there is the undesirability of conflict with the British Empire together with the resemblances between the American and Canadian peoples and the intimate friendliness of a century. Intervention in Mexico seems barred for very different reasons; our past difficulties with that country have arisen either from the weakness of its government or from ill treatment of foreigners there. Therefore, if we intervened and then withdrew it is a little hard to see how such action would either strengthen the Mexican government or would endear foreigners in general and our citizens in particular to the Mexican people. If, on the other hand, we permanently occupied the country it would have to be absorbed into the United States with the result of increasing racial and religious friction of which we have already more than enough.

Much the same might be said of the sending of another American Expeditionary Force to Europe. The United States would do so only with the greatest reluctance but nevertheless the necessity might again occur. It is not merely a question of wars between national states; there has arisen in Russia a government possessed by the new and intense religion known as Communism and should the

existing Communist Crusade gain headway in Europe—happily at the moment it shows few signs of doing so—and should non-Communist elements abroad appeal to us for help we might see fit to join in an anti-Communist Crusade.

A third unhappy contingency seems perhaps a little less unlikely than intervention somewhere in North America or in Europe, that is armed support of an aggressive foreign trade policy. Throughout the civilized world, parallel to the class struggle between proletarian and capitalist already mentioned as a possible cause of internal disorder, there has developed an international competition for raw materials and for markets. The foreign trade of the United States, although still small as compared with domestic business, has greatly increased. Should it continue to grow then our government will find itself involved in a form of international competition which might very probably end in war. Such conflict need not involve aggression on our part; some other power or group of powers might take the hostile step of excluding us from some valuable market to the enjoyment of which we had grown accustomed and of which the loss would be severely felt. Or again we might find ourselves cut off from some raw material obtainable only abroad but necessary to our economic well being. The writer is not arguing in favor of an active policy of promoting American foreign trade, far from it. He is concerned merely to note that we are already half embarked upon such a policy and to show the military consequences reasonably to be expected if we persist.

BEFORE raising the question of what sort of land force might be best for the various purposes aforesaid, we must first ask whether the United States has any defined military tradition. Like individuals nations have fixed habits which they will change only upon evident necessity. A glance at the already considerable military history of the United States shows that such a national tradition most certainly exists. It is that of acting with improvised forces gathered about a small permanent nucleus.

It is not that the American people are lacking in combativness; an enemy would be mistaken in so assuming. Indeed such an enemy, were he writing against the national character, would find it less difficult to make a case against us as unduly active and war-like than unduly supine. Considering their sparse population and loose political structure, the original Thirteen Colonies made a considerable military effort in the Revolution. The evacuation of Boston and the campaign of Saratoga, not to mention the American share in the campaign of Yorktown, were in their little local way notable feats of arms. In the land operations of the War of 1812 half a million men were mobilized at different times and the disgraceful record of failures was somewhat relieved by Jackson at New Orleans. The Mexican War was a workmanlike operation. The Civil War was fiercely fought and long before its end both sides were using the draft, i. e., conscription. The volunteers of 1898 were eager to fight. In 1917 conscription went through at once, nor will the actions fought by the A. E. F. in France soon be forgotten by either enemies or allies. Indeed with all our shortcomings the chief fault found by our allies with our combat divisions was not slackness but unnecessary losses suffered through lack of caution. Even after making full allowance for the youthful vigor and freshness of our troops compared with Europeans worn and dulled by four years of the trenches, still it would be a little hard to prove from the record that our people are abnormally unwilling to fight. It appears therefore that the national aversion to peace-time training is merely unwillingness to interfere with civilian activities.

It has been argued that the United States should no longer rely upon improvised forces and should on the contrary adopt some form of universal training and service. In particular the case for the so-called Swiss system has been put with great clearness and force by Gen. John McAuley Palmer's "Statesmanship or War" (Doubleday, 1927). And it is true that universal service is better suited to certain forms of the democratic theory than any volunteer system. Doubtless conscription of the mild Swiss type would secure us from invasion at far less cost in money than our present land forces and large navy. And if the American people could be convinced that without conscription they are insecure, that would be another matter. But in spite of the high ability of General Palmer, who has made a notable addition to the slim shelf of first-rate American military books, where the argument breaks down is that no military necessity can be shown for any such considerable interference with civil life.

Since this is so it is idle to talk of peace-time conscription for the United States. Be the supposed social benefits of such a policy never so great, it is clear that the American people are not so passionately devoted to the "all men are equal" idea that they are willing to accept its logical consequence—which is that since all cannot be equally comfortable therefore all should be equally uncomfortable. The writer is by no means suggesting that our young men would find training unpleasant; the term uncomfortable is used merely to indicate that under conscription they would be forced into inconvenience and a few mild hardships which they as individuals had not freely chosen to undergo.

Since we can be reasonably certain that the American tradition of relying upon improvised forces gathered about a permanent nucleus will be continued, our problems of organization and supply should be stated in terms of that certainty.

As to supply, a correct policy has already been adopted by the Ordnance Department, the principle (identified with the names of General Williams and General Ruggles) of leaning heavily upon civilian sources of manufacture. The enormous demands of contemporary war for ordnance matériel would in any event point to this conclusion. But, in addition, reliance upon improvised forces would seem to make it inevitable. A conscript country can to some extent budget in advance and lay in reserve stocks sufficient to last for a certain time; the promise of still further changes in matériel would make the wisdom of such action questionable but it might be taken. For us such conduct would be hopelessly wasteful—and inefficient even at that. It is therefore to be hoped that the Williams-Ruggles policy of relying upon civilian manufacture will be permanently maintained.

The problem of combat organization (upon which all details of supply depend) is three-fold. First, what form should the nucleus take? Second, what foundation for an improvised force can and should be laid? Third, how should the relation of nucleus and improvised force be conceived; should it be amalgamation or unamalgamated use

for different purposes side by side? And all these questions must continually be referred back to the three purposes of emergency police work, security against invasion, and contingencies of national policy.

HOW well then does our present establishment under the National Defense Act of 1920 answer our national requirements?

Anticipating the objection that publicly finding fault with the Act might play into the hands of those politically hostile to proper preparedness, it is suggested that unless the Army and its friends begin to ask themselves this question and consider how our organization might be more closely adapted to our national needs, they may find themselves forced to defend a most difficult position against strong political attack. And it would add to the political difficulty that the arguments against the Act would be easily grasped by the general public.

The primary argument against our present National Defense Act is that it anticipates an army of a vast size utterly uncalled for by any probable requirement of the United States. Secondary to this, but nevertheless of great force, is the further argument that the organization of our important nucleus, the Regular Army, is unduly neglectful of the great and demonstrated power of the new weapons, the airplane and the tank.

Let us take these points in their order. That the National Defense Act contemplates a huge army cannot possibly be denied. The recent annual report of the Adjutant General lists over twelve thousand commissioned regular officers and over a thousand warrant officers on the regular active list together with over a hundred thousand commissioned reserve officers. These numbers alone would provide well over one regular officer and over ten reserve officers for every four hundred enlisted men of an improvised force of four million. Even for such a military monstrosity our officer numbers are generous. Halve the numbers of the improvised force to two million and our swollen officers' list becomes fantastic. Add to this again that we have over three hundred reserve officers' training units aggregating well over another hundred thousand candidates for reserve commissions—all this from the Adjutant General's official report just published—and you have the elements of a situation unparalled in the military history of the planet. Compare for instance the thirty-six thousand regular commissioned officers of Imperial Germany in July, 1914, with our twelve thousand two hundred and fifty-five in 1930; ours are more than a third of the German figure.

Now let us weight the argument heavily in favor of the National Defense Act and the situation it has produced. Let us assume that the airplane and the tank do not exist. It is true that such an assumption is on all fours with the cynical jest that nations spend their time in preparing either for the last war or for the war before the last—which would bring us back, say, to the Russo-Japanese War of 1905. Even on such a basis as that let us see if we can justify the policy.

That the United States will never require two million, let alone four million men for emergency police work is obvious to the point of truism. The real necessity—as opposed to the occasional desirability—of emergency police work is in repressing insurrection and for that a comparatively small force of high quality, able to strike hard and quickly, is what is wanted. For such jobs quantity is unimportant and quality is everything. The success of such a force as the small State Constabulary of Pennsylvania in that turbulent state as compared with the comparative failure of the immensely more numerous local militia—whose virtues do not include that of ideal adaptability for police work—is well known. It is a commonplace of military history that a regular army of not unreasonable size could have nipped the Confederacy in the bud in 1861. If, on the other hand, an insurrection were to gain such headway as to be impossible of repression by a comparatively small but good, and of course not tiny, regular force, then no such vast organization as we now possess would be of use because it would be divided against itself through sympathy with the movement. That is, any such vast affair would appeal to great masses of our citizens or it would not spread and if it possessed such an appeal then many of our huge officers' corps would themselves feel attracted to it and our government would be in a position of having itself trained leaders who would put themselves at the head of its enemies like the regular officers from southern states in the Civil War.

If then no huge force will ever be needed for emergency police work, what are the chances of its being needed to resist invasion? Given the strategic situation in the United States it seems reasonably certain that only a coalition of great naval and military strength combined could attempt to invade us. No such coalition at present exists or could be promptly and secretly formed. Even did it exist, it would first have to win an overwhelming naval victory before invasion could be begun. That such a coalition could bottle up the United States Navy as completely as the German Navy was bottled up in 1917-1918 is most improbable and even then the transport of the A. E. F. to France was an enormously tedious and difficult business. Whether or not the same degree of security obtainable from our present fleet together with a comparatively small armed force might be had more cheaply in terms of money we need not here inquire; what is now under discussion is the present policy of maintaining our existing large war fleet and at the same time planning for an enormous army in which quality is necessarily sacrificed to quantity. In the present state of the world and with our present naval strength the chances of our needing such an army appear negligible.

It is even more improbable that the contingencies of our national policy will require the use of an enormous land force outside our own borders. We have seen that our continental neighbors possess only five and eleven per cent of our population. In the event of our being required again to send an expeditionary force overseas, an army of high quality would have obvious advantages over one of huge quantity; it would be easier to ship, supply and feed. Such a force sent out in support of an aggressive economic policy, i. e., to assure us a certain market or raw material, would be almost sure to go to regions either of sparse population or low economic development or both. And in such regions great numbers defeat themselves through the difficulties of supply; the size of a force usefully to be employed in an area being determined by population density together with degree of economic development. Thus the British armies in the American Revolution were excessive in numbers relative to the resources of the Thirteen Colonies and were

continually cramped in consequence. In his "First Reflections on the Campaign of 1918" (Henry Holt and Co., 1920), the late R. M. Johnston put this point with great force: "Low trained masses may secure a negative result in the great industrial agglomerations; but in the remote regions it is the smallest possible force of the highest possible training that will command positive results." Whether or not one need to agree with Johnston as to the ". . . . great probability of wars in remote or sparsely peopled regions, in Asia, South America, or Africa, for the control of important economic areas," it is certain that if such wars are fought they will be won not by quantity but by quality in the troops.

It would seem therefore that even if we assume the military conditions of 1914, or for that matter of the Russo-Japanese War in 1905, still the chance of the United States requiring huge more or less low grade armies is very small. Returning from this arbitrary assumption to the real world buzzing with airplanes and bristling with tanks greatly reduces even that small chance.

What the future relation between ground and air forces will be we need not here attempt to determine, or to what extent the latter will be permitted to override the accepted moralities of war by direct attack upon civilian populations. At all events it is clear that the air weapon is of great power. It will be remembered that a distinguished officer, General Mitchell, was recently willing to risk, and in the event to sacrifice, his military career for the sake of its more rapid development. And it is also clear that an infantry army of the old type, such as all very numerous armies must be, is far more vulnerable to air attack than a mechanized army containing a considerable proportion of tankmen.

PASSING from the question of whether improvised forces of enormous size are likely again to be required for our national needs, let us consider the organization of our permanent nucleus, the Regular Army, and its relation to the improvised force which in some form will take part in whatever serious wars the future may bring. Mention of the plane and especially of the tank leads us to the question whether our Regular Army is organized to take sufficient advantage of the new weapons. And this in turn carries with it the further question of the relation between the nucleus and future improvised forces.

Of mechanization little need be said; our shortcomings are so well known to educated soldiers throughout the world. One may instance the temperate and objective article of Captain Cammas: *"La Motorization Dans L'Armée des Etats Unis"* in the *"Revue Militaire Française"* of May, 1930. Briefly then, motor transportation, and in particular the tank which did so much good service throughout the second half of the war against Germany, have developed enormously in the twelve years since the Armistice. As opposed to the five miles an hour of the wartime tanks the Christie 8½-ton tank (model T3), will do 60 an hour by wheel on roads and over 42 by caterpillar over bad ground. Already it is seriously suggested that infantry, the decisive arm throughout ancient and modern times, may become as secondary to the tank as it was to the armored horseman of the Dark and Middle Ages. Even assuming for the sake of the argument that such Englishmen as J. F. C. Fuller and Liddell Hart put the case for the tank too strongly, still it seems reasonably certain that superiority in tanks will compensate for a considerable inferiority in the older arms. So great is now the mobility of tanks that only an opposing tank fleet seems able to bring up sufficient anti-tank weapons in time to meet their attack. England has actively mechanized. We have experimented on somewhat limited funds, with various types of tanks and only within the last few months has an experimental mechanized force been ordered.

Such inactivity tells its own story. Granted freely that the responsibilities of supreme command are heavy so that all should be slow to blame those who must bear them. Granted further that it is well that the supreme command should lean somewhat to the conservative side in accepting notions not yet fully tested in battle. Nevertheless there is a point at which conservatism becomes blameworthy. Our unwillingness to make even moderate sacrifice in order to do something with a new weapon of vast power seems strange. And when we consider our enormous continental distances and our unequalled automobile industry it seems stranger still.

In this connection it is interesting to note the following from a New York *Herald Tribune* editorial of November 15 (1930): "In the armies of all the great powers the processes of 'mechanization' already have reached a point which suggests that the war making of 1914-18 will soon be as obsolete as that of Waterloo. The latent possibilities of airplanes and poison gas are often discussed, but the changes in the other arms may be even more important. Since the Armistice the development of tanks, armored cars, motorized infantry and artillery ('portée troops'), high-powered guns, intricate sighting instruments, has gone very far. The war of the future is now being visualized as a conflict between relatively small armies in which the power of the individual soldier will be multiplied enormously by mechanical devices, until in war, as in modern industry, the individual, from being a fighter, will become a specialist tending a fighting machine.

"Such an army will have to be small, for the simple reason that no nation's industry could build more than a certain number of these machines, to say nothing of manufacturing the enormously increased quantity of ammunition they are capable of firing away or of keeping up the services of supply which they will require. Man power in the field becomes relatively less important; industrial power and command of raw materials become relatively more so." Since the *Herald Tribune,* although a paper of high standing, does not specialize on military subjects, its comment shows how strongly such ideas are already, and, indeed it must be admitted, quite logically, affecting intelligent civilian opinion.

Whether the National Guard may be improved by emphasizing quality at the expense of quantity would seem an open question. Higher quality could be secured by eliminating such officers and men as would be unable or unwilling to spend a considerable part of the summer at maneuvers. Whether the change would be worth while would depend on how far this intermediate force, the Guard, is to be considered part of the nucleus. At all events the Guard's existence ought to make it possible to lengthen the instruction period for such improvised formations as may be intended for the more serious and important tactical work.

CLEARLY the third problem of combat organization, the relation between nucleus and improvised force, depends upon the form given to the nucleus. If the Regular Army is to remain primarily an infantry army then it is debatable how far its personnel should be distributed among the new wartime units. If, on the other hand, the peacetime mechanization of the regulars goes forward, each step in the process will make it more desirable to use a large proportion of them in their original units promptly upon the outbreak of hostilities. Such use would leave some scope for the employment of wartime recruitment in those units; just as a strong wine—say a Burgundy—can be considerably watered and still remain highly palatable wine, so the officers and non-coms of a good regular outfit can quickly absorb a considerable proportion of high grade wartime recruitment without grave loss of quality. And at the other end of the scale some wartime duties can be adequately performed by troops inadequate to take the field. Thus any zealous middle-aged man with a brassard and no matter what sort of a firearm can serve in the home guard to protect bridges, tunnels and important factories as well as anyone. The State guards of 1917-1918, fully uniformed and marching with cadenced step through our streets, were merely indulging a laudable military enthusiasm and procuring a profit to the clothing manufacturers.

The preparation of improvised units for wartime field service with the new matériel will inevitably require time and even with such units quality rather than quantity of recruitment will be important. Of this we have already had a foretaste in the wartime use of the Enfield rifle; in the hands of a trained man the U. S. Army Springfield was a better weapon but for the drafted men the clumsier but more solid Enfield was rightly chosen. Again in the Army of the Potomac it was not until well into the Civil War that the cavalry, generals and privates alike, began to avoid hopeless and unreasonable wastage of horses. Multiply these difficulties by the complexity of contemporary weapons, add to that again the necessity for intelligent coöperation in combats of which the phases will shift as rapidly as fast tanks can move, and you have the problem of future improvised forces. All of which tells in favor of an adequate regular army and national guard but by no means rules improvised forces out. Given the high level of mechanical aptitude among our people, our college men and our automobile mechanics would be excellent recruitment either for bringing existing mechanized units up to war strength or—within the limits of such improvisation—for organizing new units.

In conclusion, let us remember Clausewitz's axiom that war is only a continuation of policy by other means. Let us remember Foch's perpetual *"de quoi s'agit il,"* what are we trying to do? If the National Defense Act can be shown to suit our national requirements by all means let the arguments in its favor be brought forward. If indeed there are no such arguments then let the Army and its friends move forward before they are politically compelled to move back.

On Guard at Mother Manhattan's Jewel Box.

A. O. A. Post Established at Birmingham

Alabama Industrialists Promote Munitions Preparedness

COLONEL Frederick H. Payne, the Assistant Secretary of War, was the guest of honor and principal speaker at a banquet and meeting of engineers and executives of the Birmingham Ordnance District, under the leadership of Col. Theodore Swann, Ord. Res., for the formation of a local post of the Army Ordnance Association in that territory. The meeting was held in the banquet hall of the Hotel Tutwiler, Birmingham, Ala., December 3, 1930, and was attended by more than 100 members of the Army Ordnance Association and guests. Other honor guests and speakers were the Hon. Benedict Crowell, President of the Army Ordnance Association, former Assistant Secretary of War and Director of Munitions during the World War; Maj. Gen. Samuel Hof, Chief of Ordnance, U. S. Army, and Maj. Gen. Frank R. McCoy, Commanding General, 4th Corps Area. Colonel Swann was toastmaster.

Colonel Payne explained the procurement planning activities of the Office of the Assistant Secretary of War and stressed the various functions of his organization. He congratulated the members of the new post on their interest in industrial preparedness and their willingness to share in a better understanding of the importance of industrial mobilization. General Hof described the place of the Ordnance Department in our scheme of national defense and described the industrial aspects of the problem. Mr. John Temple Graves, II, of the editorial staff of the *Birmingham Age-Herald,* spoke on the industrial importance of Birmingham and neighboring areas.

Unusual entertainment features were provided during the banquet. A special radio program was broadcast to the banquet hall from a nearby station at Birmingham. "Henry and Percy," the local version of Amos and Andy, paid their respects to all officers of the organization with very timely remarks.

HAVING complied with the prescribed regulations of the Constitution and By-Laws of the Association, the new post adopted its constitution and proceeded to the election of officers. The President of the new post is Col. Theodore Swann, an outstanding figure in the industrial life of the South. He is president of the Swann Chemical Corporation, a director of the First National Bank of Anniston, First National Bank of Birmingham, and the Bankers Mortgage Bond Company. He served as a member of the U. S. Naval Consulting Board during the World War and upon the establishment of the Birmingham Ordnance District became the Assistant District Chief.

Col. George Morrow, vice-president of the Goslin-Birmingham Manufacturing Company, was elected vice-president of the post. He was graduated from the United States Military Academy, class of 1906, and resigned from the Army in 1930 to become associated with the Birmingham Machine and Foundry Company. During the World War he served as a lieutenant colonel, 56th Field Artillery.

Col. John Stephen Sewell, Chief of the Birmingham Ordnance District, was elected a director of the national association to represent the Birmingham Post. Colonel Sewell is well known in military and industrial circles, being a graduate of the Military Academy, class of 1891. During his service as a member of the Corps of Engineers he supervised the building of the new Government Printing Office, the Army War College and the Agriculture Department buildings at Washington. He resigned from the Army in 1908 to become vice-president and general manager of the Alabama Marble Company and reëntered the military service when America entered the World War in 1917. As a colonel in the Engineer Corps he organized the 17th Engineers Railway and after the Armistice established Base Section No. 9 with main headquarters at Antwerp. When mustered out of the service in 1919 he became president of the Alabama Marble Company and is now in charge of all foreign participation in the 1933 Chicago World's Fair.

The following were elected directors of the post:

Robert I. Ingalls, president, Ingalls Iron Works Co., Birmingham;

Samuel F. Clabaugh, president, Alabama National Life Insurance Co., and Protective Life Insurance Co., Birmingham;

Thomas E. Kilby, former Governor of Alabama, now president of Kilby Car and Foundry Co., and chairman of the Board of the Anniston National Bank and the Alabama Pipe Co.;

George Woodruff, president of the Continental Gin Co.;

Landers Sevier, president, Associated Industries of Alabama, formerly vice-president of the Seaboard Air Line Railroad and of the Sloss-Sheffield Steel and Iron Co.;

Morris W. Bush, vice-president, Alabama By-Products Corp., Birmingham, Ala.;

Maj. C. H. Menger, Ord. Res., former executive assistant, Birmingham Ordnance District, and now associated with the Alabama Power Co.; and

Herbert Stockham, president, Stockham Pipe and Fittings Co., Birmingham.

At the meeting Colonel Swann announced the appointment to the Advisory Board of the Birmingham Ordnance District of Mr. Erskine Ramsey, president of the Pratt Coal Co., vice-president of the Tennessee Consolidated Coal Co., and an outstanding figure in the coal and iron industry, with which he has been identified for many years.

Maj. Ralph E. Parker, Ord. Res., Chief Estimator in the Tennessee Coal, Iron and Railway Company, was elected treasurer.

Capt. David N. Hauseman, Ord. Dept., U. S. A., executive officer of the Birmingham Ordnance District, was elected secretary of post. He was graduated from the University of Pennsylvania in 1917 and is a graduate of the Field Artillery School, Massachusetts Institute of Technology and the Ordnance School.

IN PRESENTING the charter to the president of the new post, Mr. Crowell said:

"Mr. Chairman, Mr. Assistant Secretary and gentlemen of the Birmingham Post: I have been looking forward for

Officers of Birmingham Post, Army Ordnance Association

George W. Woodruff

Theodore Swann

George W. Morrow

Landers Sevier

C. H. Menger

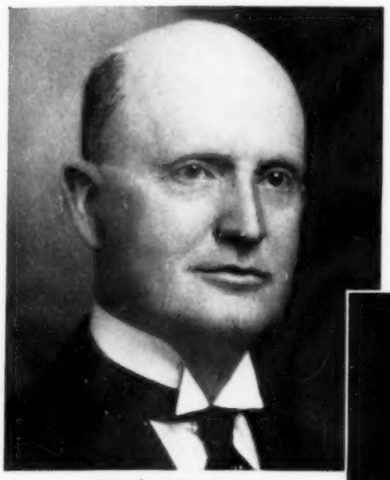
Robert I. Ingalls

Maj. Ralph E. Parker

Capt. D. N. Hauseman

Colonel Swann is President of the Birmingham Post, Colonel Morrow is Vice-President; Messrs. Woodruff, Sevier, Menger and Ingalls are Directors of the Post; Major Parker is Treasurer and Captain Hauseman, Secretary.

Leading Figures in Ordnance Activities at Birmingham



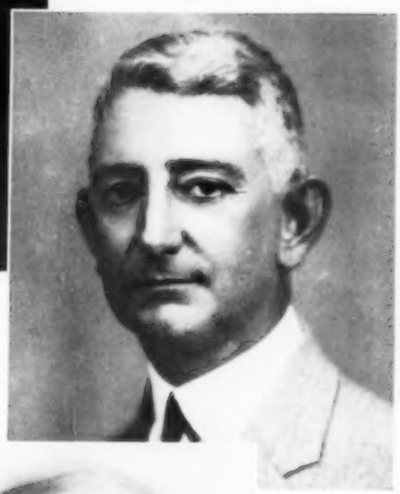
Erskine Ramsey

Thomas E. Kilby

John Stephen Sewell

Frank H. Crockard

Morris W. Bush



Herbert C. Stockham

Sam F. Clabaugh

Mr. Ramsey and Mr. Crockard are new members of the Birmingham District Advisory Board; Colonel Sewell is a new Director of the Association; Governor Kilby and Messrs. Bush, Stockham and Clabaugh are Directors of the Post.

a long time to this visit. I was much pleased to learn from Colonel Swann several months ago of your plans for the formation of a post of the Army Ordnance Association here in Birmingham, and it is a real pleasure to be with you this evening for this charter meeting of your new organization.

"I can not let this opportunity pass without paying tribute to the excellent work for munitions preparedness that has been done and is still being done so splendidly by Colonel Sewell, the Chief of the Birmingham Ordnance District, and by the very capable Assistant District Chief, Colonel Swann. The gentlemen of the Birmingham District Advisory Board also have contributed in very highest degree to the work of the Government for munitions preparedness. They and all of you who are interested in this problem are entitled to congratulation for your splendid effort.

"It is not my purpose this evening to elaborate on the important work of industrial war planning which Assistant Secretary Payne and General Hof have discussed so thoroughly. My function as President of the Army Ordnance Association is to welcome the Birmingham Post into our nation-wide organization and to confer its charter.

"The Army Ordnance Association looks to such local organization as this for the stimulation of a more active and continuing interest in munitions preparedness. Only through our posts are we able to maintain that degree of intimate contact which is so essential in a national organization such as ours. This has been proved by the history and activities of our other local posts of which there are ten beginning with that of New York which was established in 1921, including those formed in the intervening years, the most recent of which was the Milwaukee Post established in 1928.

"In our organization the national association leaves entirely to the officials and members of the several posts the conduct and planning of their respective activities. Consequently your new post, in whatever program it adopts, is left entirely to your own wishes. The national association will coöperate in all your efforts. Many of our posts hold quarterly meetings for the discussion of ordnance development and industrial war planning, while in other localities it seems sufficient to hold post meetings only semi-annually or annually. Others meet monthly during the winter season; all of them, conforming best to their own local conditions, are contributing in great measure, through discussion, study and planning, to the advancement of industrial preparedness.

"The Army Ordnance Association is an unique organization. It supplements as best it can the industrial war planning activities of the Government and endeavors to assist through every possible means in the perfection of those all-important plans. Ours is not a trade organization for the simple reason that there is no such thing as a munitions industry in America. It is not a service organization because less than 9 per cent of its members are officers in the Regular Army. It is technical and scientific inasmuch as ordnance is technical and scientific. It is composed for the most part of executives and engineers in industry who see in industrial preparedness one of the vital national defense problems of the nation. In my judgment there is no more patriotic or more important field of coöperation in which such men as yourselves could take part.

"Indeed as time goes on and prospectives widen I become more firmly convinced of the need and value of such an organization as ours. Without the stimulus which our Association gives a knowledge of the design and manufacture of munitions might easily dwindle away. If such a condition should obtain, our country would again be in the same deplorable status in which it was before the World War. Many of you are familiar through actual experience with the delays and waste of time and money in the production of munitions in that emergency, and this in spite of the magnificent effort of American industry to meet the war-time burdens placed upon it. Our problem would have been far simpler and our losses would have been almost halved if there had been at least a general knowledge on the part of our engineers and manufacturers as to the characteristics of munitions design and the methods of production. Thus I say an organization such as ours which aims to keep alive that knowledge and interest is performing a very valuable patriotic service, and I am sure you gentlemen of the Birmingham Post share that same viewpoint. The formation of this post here in Birmingham is evidence that you do.

"Therefore, I consider it a real privilege as President of the Army Ordnance Association officially to recognize the existence of the Birmingham Post and, in accordance with the Constitution of our Association, to issue its charter. Mr. President, I am confident of the success and real value of this new local organization, and in presenting the charter I extend the congratulations of the entire organization to you and the members of the new post. All thinking citizens will thank you most heartily for your interest and cooperation in industrial preparedness which, in my judgment, is not surpassed in importance by any other national question."

THE constitution adopted by the new post contains the following provisions:

"Objectives—To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace; to keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design, standardization and production of ordnance material; to promote mutual understanding and to effect coöperation between American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Army Ordnance Department; and to assist the Army Ordnance Association in its work in the Fourth Corps Area, the Birmingham Ordnance District, and in the Ordnance Reserve Officers Corps units of the educational institutions.

"Membership—Full membership in the Birmingham Post of the Army Ordnance Association shall be open to all men who are members of the National Army Ordnance Association residing in the Birmingham Ordnance District who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"The Board of Directors—The Board of Directors shall consist of the president, who shall be ex-officio chairman; the past president of the previous year, the vice-president and eight directors. The Board of Directors shall have full control of the activities of this post, subject to the limitations of the Constitution and such By-Laws as may be adopted thereunder."

The Development of Army Ordnance

Investigations and Results in the Improvement of Weapons

By Brig. Gen. William H. Tschappat*

THE barbette carriage, Model 1919, is a fixed mount for the 16-inch, 50 caliber gun. A number of these have been built and emplaced. The gun fires a projectile weighing 2,340 pounds approximately 28 miles. The carriage permits 65° elevation and 360° traverse. The purpose of a weapon of this power is the defense of some important locality. The carriages are equipped with electrical devices for elevating, traversing, loading, ramming and lighting. The breech block is closed by compressed air which is also used for expelling residual powder gases from the bore. Provision is made so that in case of difficulty the carriage can be operated by hand.

The above-mentioned major caliber weapons represent the more modern types in service as well as the most recent developments. It is important to note in this heavier armament the trend toward high-angle fire, long range, wide traverse and to some extent mobility.

At a recent firing practice with a 16-inch gun on the Pacific side of the Panama Canal at a range of 42,000 yards, using airplane spotting, an actual hit was made by the Coast Artillery on a pyramidal target.

ONE of the outstanding accomplishments in the field of ordnance since the World War is the development of greatly improved antiaircraft artillery and entirely new matériel for antiaircraft fire control. The antiaircraft problem is an exceedingly difficult one. Given an airplane somewhere in the sky, we must find out how far away and how high it is, its direction and speed, and then we must compute the proper sight settings to enable the gun to be so pointed that at the expiration of the time of flight for that range and elevation the fast moving plane and projectile will meet at the same point; and moreover, the fuze must be set so that the projectile will burst at exactly the right time.

This problem is badly complicated by the great speed of the target and by its ability to change its direction in any of three dimensions with very great rapidity. This means that the time element enters so importantly into the problem that the computations must be instantaneous and continuous, and that the gun-laying and fuze-setting must be accomplished at the same moment that the computation is made. The heart of the antiaircraft fire-control system is an instrument known as the director. It is essentially a computing machine which automatically and continuously observes the target and computes its future position in space, translating its computations into the movement of pointers for the azimuth, elevation and fuze-setter dials.

You will recall that the greatest development in antiaircraft fire control at the end of the World War was the Routin director. This instrument had a dead time of 8 seconds and sometimes a greater dead time due to the requirements of setting-in data and operating the instrument after data were assembled. With the higher speed of airplanes, a lot could happen in 8 seconds, and it was essential that the Department develop an instrument which would produce continuous data, leaving as the only dead time that time which elapsed between the discharge of the cannon and the arrival of the projectile at the target.

THIS solution has been accomplished in three directors. The first one, designed by the late Major Wilson of the Ordnance Department at Frankford Arsenal, was later perfected by the Sperry Gyroscope Company of Brooklyn, N. Y., to produce results beyond those which had been contemplated in the early days of the design. This director is known as the T6.

In 1925 the Department learned of the development of a Vickers director in England and procured one of these through the Military Attaché at London. This director has been greatly improved by suggestions from our antiaircraft designers and from the designers of the British War Office, until it is now firing at the proving ground with almost uncanny accuracy at such times as it receives proper data and proper handling.

In 1928 an Ordnance Military Attaché in Paris discovered a director produced by Mr. Papello, of Talinn, Esthonia, which has since been procured. This director combines with it a height-finding feature which is very ingenious and also has an ingenious rate-measuring instrument for the prediction of the position of the target in space. The inventor, with his instrument, is now at the Aberdeen Proving Ground and the instrument has been perfected considerably since the original type.

These three directors with their different methods of solving the antiaircraft problem indicate clearly that a satisfactory solution of setting continuous data on the gun carriages has been reached and there now remains the question of perfecting the instruments and cheapening their manufacture.

FOR short-range fire, directors have been developed for machine guns and 37-mm. guns, but the angular velocity of a passing target is so great at short ranges that the directors have little time to stabilize themselves and produce accurate data. By using tracer ammunition and a stereoscopic instrument for observing the tracers with respect to the target in the air, a more satisfactory solution has been reached for this short-range problem. We have a two machine gun mount fired by an operator who controls his fire through a stereoscopic instrument and the 37-mm. mounts in which the operator controls the setting of the sight through his stereoscopic instrument. In each case he observes the tracer bullets as they are passing the target.

The data receiver mounted on the carriage receives and displays the data from the director. The gunner traverses

*Assistant to the Chief of Ordnance and Chief of the Manufacturing Service, Ordnance Department, U. S. Army. This is the concluding part of an address by General Tschappat to the members of the Army Ordnance Association at the Business and Technical Session of their Twelfth Annual meeting in the Auditorium of the U. S. Chamber of Commerce, Washington, D. C., October 8, 1930. Part I appeared in the November-December, 1930, issue of this Journal.

or elevates his gun to keep the pointers in coincidence. On a few fixed carriages torque amplifiers automatically follow the pointers and keep the guns set on the targets.

In operating the director, there is one quantity which must be determined independently, and that is the height of the plane. The Lavallois 4-meter stereoscopic height finder is one type of instrument for making this determination. There are several makes of height finders and there are two general types in use: the stereoscopic and the coincidence. The stereoscopic instrument operates by reason of our ability to see in depth and sense an object as being in front of or behind another object. This faculty of stereoscopic vision is derived from the spacing of the two eyes, and is in a way equivalent to a range-finding system employing two observing stations at the ends of a measured base line. In the stereoscopic height finder the normal base line between the eyes is increased to the distance between the two objectives, thus enabling the operator to locate an actual object with a considerable degree of accuracy with respect to a known distance scale within the optical system of the instrument.

The detection of airplanes from the ground at night presents new problems and requires additional apparatus. To locate planes flying at high speeds in the dark appears at first thought to be a problem incapable of solution. However, a special apparatus has been developed by the Ordnance Department for locating airplanes by sound. This instrument, called the sound locator, can be depended upon to give the position of a moving plane with an accuracy of about 15 minutes in azimuth and angle of site.

A battery of four of the latest type of 3-inch antiaircraft guns was built and emplaced at the Aberdeen Proving Ground in 1926, and approximately 9,000 rounds have been fired from this battery with highly gratifying results. These guns are equipped with Sperry torque amplifiers by means of which the operation of the director automatically lays the gun in elevation and azimuth instead of requiring the guns to be laid mechanically by having the gunner follow the pointer with the elevating and traversing mechanisms. This battery is also equipped with continuous type fuze setters, operated by means of a hand wheel matching the two pointers on a dial at the top of the instrument, and in so doing introduces the proper fuze range. The projectile is inserted in the bell mouth opening and automatically locked in position. An operator turns a crank at the rear through two complete revolutions, and this gives the proper fuze setting. As long as the projectile remains in the fuze setter the setting is continuously corrected. It can not be withdrawn until the setting is correct.

THE 105-mm. antiaircraft gun on fixed mount is the most powerful weapon yet tested by our service. The gun is 60 calibers in length (the longest gun in calibers ever built in this country) and is equipped with a loose liner to permit replacement in the field. The removable liner represents a marked advance in gun construction as it does away with the necessity for sending a worn gun to an arsenal for retubing. The cost of a liner is less than the cost of retubing, and the installation can be made in a few minutes by the battery personnel using simple hand tools. Both gun and liner are made by the cold-work process.

The gun is designed for a muzzle velocity of 3,000 feet per second and will fire a 33-lb. projectile to a height of 14,000 yards with a maximum horizontal range of 20,000 yards. The increased weight of the shell, as compared with the 3-inch 15-pdr. projectile, provides a large increase in the danger zone, or effective area of the burst. The high muzzle velocity and greater weight of projectile considerably reduce the time of flight at all ranges. An automatic rammer system is provided to load the complete round of ammunition, which weighs about 65 pounds. The rammer mechanism is so constructed that it is thrown to the rear during the recoil of the gun, compressing the air in the rammer cylinder. To load the gun it is only necessary to place the complete round on the loading tray and pull the rammer lever. The gun is equipped with a semiautomatic breech mechanism which closes as soon as the round of ammunition is pushed home, at the same time locking the rammer head out of position. Upon firing, the breech block opens automatically and ejects the empty shell case.

The 3-inch antiaircraft mobile mount, M2, is the latest design of mobile antiaircraft artillery produced by the Ordnance Department and represents a marked advance over previous types. The carriage is mounted on balloon tires. The long outriggers are folded up at each end of the carriage. Equilibrators have been introduced to balance the muzzle preponderance of the gun when the trunnions are located near the breech. In this manner we secure a maximum elevation of 85° without the use of high side frames seen in the Model 1918 carriage. The center of gravity is held near the ground and the stability correspondingly improved. Beneath the center of the mount are two screws which are used for raising the mount preparatory to removing the wheels in going into firing position.

In considering a four-gun battery of antiaircraft artillery in action, it is necessary to recognize that the questions of stability, mobility and maneuverability are of the greatest importance in a mobile gun carriage, and all three points appear to have been successfully accounted for in the M2 mount. It is stable under all conditions of firing; it can be emplaced from the traveling position in readiness for firing in about fifteen minutes and is so light in weight that it can be towed across country by a standard 5-ton tractor or, under favorable conditions, by a 4-wheel drive truck.

The gun is 50 calibers in length and is equipped with a removable liner similar to that provided for the 105-mm. The gun fires a standard 3-inch projectile at a muzzle velocity of 2,600 feet per second. The vertical range is about 10,000 yards and the maximum horizontal range, 14,200 yards. The gun is equipped with a semiautomatic breech mechanism. A continuous fuze setter similar to that provided for the 105-mm. and 3-inch fixed mount is standard equipment for this carriage. The maximum rate of fire is about 25 shots per minute. The fire of the gun is controlled by the indirect method from the antiaircraft director.

SOME of the increases in range of artillery are due to increased muzzle velocity, length of bore and elevation, but more are due to improved ammunition, especially as to the shape of the projectile. Streamlining, boat-tailing, and alterations in shape and location of rotating bands, all of which tend to cut down the resistance the projectile meets in flight, have greatly increased the range of modern projectiles. If the present 75-mm. service projectile now in use were fired in the 75-mm. gun, Model 1920, the maxi-

mum range would be 11,500 yards as compared to 15,000 yards with the new type of projectile.

Work on the problem of manufacture of shell from seamless steel tubing was undertaken a few years ago as a war-planning measure to increase facilities and early production of explosive shell for field cannon. A piece of seamless steel tubing is cut to length, the base of the tubing closed in by a forging operation, the hole in the base drilled and tapped, and a plug screwed into this hole to close and seal the opening. The closing-in operation may be, and has been, accomplished on a horizontal forging machine and a vertical crank press. Any press of sufficient power and stroke should be satisfactory for the work.

This method of manufacture has progressed to an extent where there appears to be little doubt that it can successfully be used for manufacturing shell for calibers up to and including the 155-mm. or 6-inch. Orders are being completed at the Frankford Arsenal for shell for the 75-mm. gun, the 3-inch antiaircraft gun and the 105-mm. howitzer.

The mechanical time fuze recently was standardized for use in antiaircraft guns. The powder train fuzes do not work with satisfactory regularity when fired at very high altitude owing to the variations of the density of the atmosphere. This fuze consists of a mechanism not unlike a watch. As can be imagined, it is difficult to design a mechanical fuze which will withstand the firing stresses and will be accurate. The cost of fuzes of this type will probably limit their use to antiaircraft work. The fuze is designed to bring about the explosion of the bursting charge of a shell in the air, at a predetermined distance from the gun, with an accuracy of the timing mechanism of the fuze, which results in considerable reduction in the errors of antiaircraft firings.

The timing element of the fuze resembles a watch mechanism in general principles, although differing from it in the following respects: Instead of being driven by a main spring, it is driven by a pair of weights which make use of the centrifugal force obtained by the rotation of the projectile. Its escapement differs from that of a watch in that it beats at a very much higher frequency and makes use of a straight spring instead of the conventional spiral spring.

The advantages of such a fuze may be stated as follows: High degree of accuracy; freedom from variations in timing, due to atmospheric conditions; capable of quantity manufacture and long-time storage without deterioration. Increased accuracy of our antiaircraft matériel has resulted from this important ammunition item, as demonstrated in extensive firings by the Coast Artillery against sleeve targets towed by airplanes. Orders of fuzes have been placed and are being manufactured at the Frankford Arsenal under steady and continuous production.

The T1 point-detonating fuze is being developed to replace the war-time superquick point-detonating fuze, Mark III, and is really a modification of the latter fuze. The modification is to insure greater safety and reliability of functioning, particularly at the short ranges. Successful proving ground tests have been obtained, except in the 75-mm. pack howitzer, where unfavorable results appear to be caused by instability of the projectile. Fuzes have been issued to the service for test in the 75-mm. field gun and the 155-mm. gun. Additional fuzes are under preparation.

The T2 point-detonating fuze is a combination superquick and delay type for high explosive shell of calibers 75-mm. and larger. It may be used either for superquick action or for delay action, as desired by the using personnel. The fuze is bore safe and permits of the issue of the round completely fuzed, thus materially lessening the supply difficulties in the field. Also, it will replace the several types of single-purpose fuzes now in service, in addition to having a universal use in all calibers of point-fuzed high explosive shell. The contour of the fuze blends with the ogive of the shell, giving a streamline effect to the projectile, resulting in a superior ballistic shape. Satisfactory results have been obtained in the proving ground tests with this fuze, and several thousand of them are being manufactured for issue to the service for extended tests in the various caliber weapons.

An impact base-detonating fuze, known as the Mark X, has been developed and issued to harbor defenses for use in 12-inch and larger armor-piercing projectiles. This fuze is bore safe, that is, safe against explosion in the gun, and it is fitted with a delay element which prevents explosion of the projectile until it has penetrated caliber armor plate.

A base-detonating fuze is being developed for high explosive shell for the new 37-mm. infantry gun. This is a nondelay action type. Satisfactory results have been obtained in proving ground tests, and a number of fuzes are being manufactured for test by the services. A fuze of similar design, except that it has a short delay feature, is also under development for the 37-mm. armor-piercing shell for use against tanks. A bore-safe fuze with short delay has been designed for 2.24-inch armor-piercing shell. This is for the 2.24-inch tank gun and is designed to explode the shell after penetrating tank armor. Development and manufacture of this fuze have not yet started.

A PROGRAM of development work started in 1919 resulted in the development of a flashless, nonhygroscopic (FNH) smokeless powder for the 75-mm. gun, Model 1897, which was subjected to service tests and finally approved as standard for manufacture in 1926. A powder of the same composition, in appropriate grain size, was also approved as standard for the 155-mm. gun G. P. F. Although not flashless in this gun, the powder has the distinct advantage of being nonhygroscopic (NH). Satisfactory FNH powders of like composition have also been developed for the 75-mm. pack howitzer, the 75-mm. gun M1, the 2.95-inch mountain gun, and the 105-mm. howitzer. Those developed for the 3-inch antiaircraft guns, the 155-mm. howitzer, and the 6-inch guns, Models 1897-08 and Models 1900-03-05, are nonhygroscopic but not flashless. In 1929 the War Department approved the standardization of this type of improved powder for all calibers of weapons up to and including the 155-mm. gun. Tests covering a period of several years have confirmed the conclusions that this type of powder possesses the advantages of greater chemical stability and ballistic uniformity than service powder of the "pyro" type. A program has therefore been initiated for the development of NH powders for all calibers of railway and seacoast weapons. Within the past year entirely satisfactory proving ground results have been obtained with NH powders for the 240-mm. howitzer and the 12-inch gun, Model 1888-95, and progress has been made in the de-

velopment of similar powder for the 12-inch mortar, Model 1912. It is planned to conduct actual service tests of the new powder in these weapons before the powder is approved as standard for manufacture.

Although the present type of FNH or NH powder, which has been approved for all calibers of weapons up to and including the 155-mm. gun, undoubtedly marks a great advance in the development of improved smokeless powder as regards better chemical stability and ballistic uniformity as well as flash elimination, continued efforts are being made to effect still further improvements by a study of new compositions. Thus, it may ultimately be found possible to eliminate the flash from even major caliber guns without the production of objectionable quantities of smoke.

It has been known for many years that properly purified wood pulp, preferably converted into paper of suitable characteristics, constitutes a satisfactory emergency substitute for cotton linters as raw material for the manufacture of smokeless powder. Practically all of Germany's World War smokeless powder was made from wood pulp because of lack of supplies of cotton. Toward the close of the war a threatened shortage of cotton linters in the United States directed attention to the use of wood pulp as a substitute. No difficulty was encountered in obtaining purified pulp which would meet the requirements of our cotton specifications as regards purity. Due to the fact that the nitrating and purifying equipment available was not adapted to the use of straight wood pulp because of the fineness and bulkiness of this material, it was found necessary to use it in admixture with about an equal weight of cotton linters. Sufficient powder was manufactured from such a mixture to establish definitely that wood pulp used in this manner would produce an entirely satisfactory product. The advances of recent years in the use of highly purified wood pulps in paper form for the manufacture of nitrocellulose products such as celluloid, lacquers, artificial leather, etc., has led to further study of this material in the manufacture of smokeless powder. It is believed quite possible that the structure of the wood cellulose fibers is such that this material will yield a nitrocellulose which can be stabilized more readily and more completely than the product made from cotton fibers. If such is the case wood pulp may entirely supplant cotton linters even for the peace-time manufacture of smokeless powder. A study of the suitability of various commercial wood pulps in paper form is now in progress on an experimental plant scale at the Picatinny Arsenal.

THE Ordnance Department has done considerable work on aircraft bombs and accessories since the war. The results of this work were shown in the several bombing tests held by the Air Corps. The present types of bombs are fragmentation (for use against personnel) weight: 30 pounds; and demolition (for their destructive effect both against land targets and naval targets) now made in the following sizes: 100-lb., 300-lb., 600-lb., 1,100-lb., and 2,000-lb. Naval vessels are apparently more easily damaged by a near hit than by a direct hit.

Demolition bombs used during the war were of the stream-line type, the contour of which was based on that of the Eiffel Dirigible IV. This shape was considered necessary at the time to result in proper stabilization and true flight and thus acceptable accuracy. Since the war the design of stabilizers or fins for bombs has been developed to the point where such streamlined construction is no longer necessary. As a result, cylindrical bodies have been adopted for all post-war types of demolition bombs. These cylindrical bodies are manufactured under a process similar to that used in producing gas shipping containers. A steel plate is cupped and then drawn to form the cylindrical body portion. The nose of the bomb is thus formed integral with the cylindrical body. The rear end is closed in by a swaging operation. The advantages of this type of construction as compared with the war-time type of streamlined built-up arrangements are: Greater strength due to absence of welded joints and seams; better adaptability to chemical loading; easier maneuverability in the field; greater content of explosive or chemical loading, and easier procurement under war-time production, in that the facilities of the tube and pipe industry can be utilized.

Post-war demolition bombs are equipped with both nose and tail fuzes. The additional fuze is considered necessary to insure certainty of functioning. The fuzes now under development carry selective delay features which allow bombs to function on impact with any one of several delays, depending on how the fuze is set at the time it is assembled to the bomb. Two types of fuze action are now used, viz., instantaneous and short delay, depending on the target to be attacked. The new fuzes are equipped with safety features whereby the detonating element is out of line with the firing pin and primer until the bomb has fallen a definite distance from the plane. It is possible to release bombs with fuzes unarmed so that on impact no detonation will take place. This is desirable in case it becomes necessary to release the bombs over friendly territory due to plane trouble.

The 4,000-lb. demolition bomb Mark I is the largest bomb in the world so far as is known. It is 13½ feet long, 2 feet in diameter, weighs 4,300 pounds, and carries 2,000 pounds of TNT. It is still experimental. Theoretically, the only limit in size of bombs is that which the plane can carry; yet practically, with the targets available for attack, it appears that there is a limit beyond which little is gained by an increase in the size of bomb. The maximum size needed at present is the 2,000-lb. bomb.

One of these bombs was dropped from a Handley-Page at the Aberdeen Proving Ground in October, 1921. It was dropped from a height of 4,000 feet by Captain Carolin of the Air Corps, who stated that as the bomb was released his plane shot upward about twenty-five feet, the effect being no worse than is often encountered in the air.

A NEW light tank, approximately 8½ tons in weight, has been designed and built; it has been tested at the Aberdeen Proving Ground and by the Tank Board. Tests show this tank to be capable of three times the speed of war-time tanks. Its fire power is much greater than that of the light tank, Model 1917, as the new tank carries both a 37-mm. semiautomatic gun and a machine gun instead of only one weapon. With these improvements and many others, the mileage life of the new tank is still in excess of 2,000 miles without major overhaul compared to about 100 miles for the light tank, Model 1917. This will be still further improved as the type develops. A 135 horse power engine and

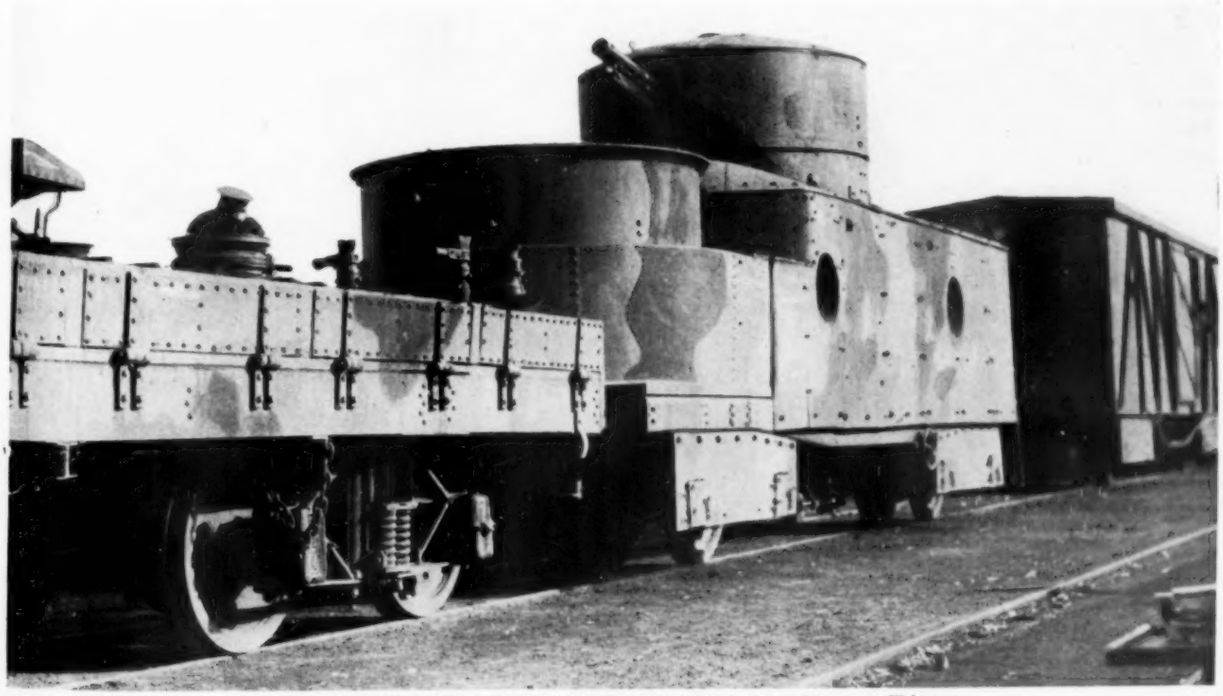
4 gear speeds give it a high degree of mobility. The crew consists of two men. This light tank is superior to any light tank known to be built by any foreign power.

A redesign of the medium tank, Model 1921, is approximately 23 tons in weight and will go 12 miles per hour with its 220 horse power special Packard engine. It will fulfill the requirements for a tank of an offensive power greater than that of the light tank, and at the same time it is more maneuverable and much faster than the 44-ton Mark VIII war-time tank with which the service is equipped at the present time. The medium tank, T1, is a very successful vehicle from an engineering standpoint, but even greater speeds are now demanded.

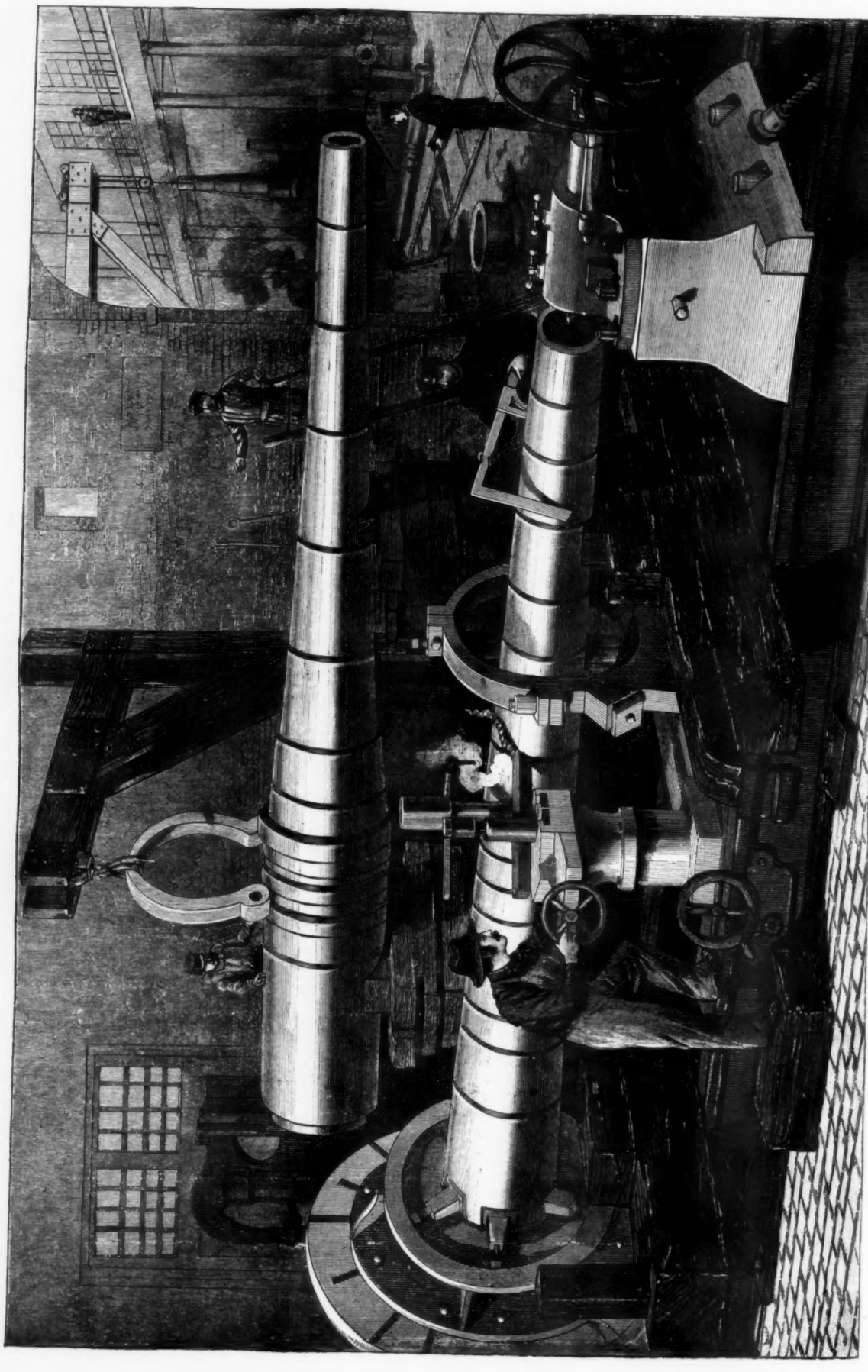
However, on account of the limitations of portable military bridges, a directive to develop a medium tank to weigh not over 15 tons was issued. A pilot 15-ton medium tank has been completed and has completed a very successful shop test of about 200 miles. This tank weights a little less than 15 tons and has a maximum speed of over 22 miles per hour, which is a remarkable speed for so heavy a track-laying vehicle. A 12-cylinder water-cooled V-type engine of over 300 horse power provides ample power at all times. A driver and three gunners comprise the crew. A new 3-pounder semiautomatic gun (the largest semiautomatic cannon yet built) mounted in a combination mount with a caliber .50 machine gun in a turret having all-around fire constitutes the main armament. In addition, there is a 37-mm. semiautomatic gun in combination with a caliber .30 machine gun, so that this tank has a greater fire power than any other tank we have built to date. So far as is known, this is, in fire power, the most powerful tank ever built. The tank is armored against caliber .50 armor-piercing bullets. While we have very few new tanks, it can fairly be said that our post-war experimental tanks are fully the equal, and in many cases the superior, of tanks developed by foreign countries.

There is now under manufacture for the Ordnance Department a Christie convertible wheel-and-track tank. This machine is designed to operate like a truck on wheels over improved highways and to operate on caterpillar tracks, applied over the wheels, when bad terrain is encountered. Several vehicles embodying this idea have been built by Mr. Christie and some in foreign countries as well. A chassis of this type with certain improvements impressed the Infantry so favorably that the War Department decided to buy a tank built on this principle for a thorough technical and service test. The specifications for this tank, which Mr. Christie says he can meet, are in general that it will not weigh over 15 tons armored and armed as a light tank. A 330 horse power Liberty tank engine is to drive it 40 miles per hour on its wheels and 30 miles per hour on its tracks. Should this tank be successful it will be an important step forward in the mechanization of war.

FOR the transportation of all medium and heavy artillery under certain conditions, tractors of the full track-laying or caterpillar type have demonstrated their superiority as prime movers. Although military requirements are such that a fast tractor would seem to be necessary, this would require the development of a special tractor for this purpose. The use of special tractors would create serious difficulties and delays in getting into production in time of emergency and would cost much more than commercial vehicles. Therefore, the War Department has adopted as standard for issue certain commercial tractors. The "Twenty" tractor has been found suitable for moving a single axle load of the divisional artillery (75-mm. guns). The "Thirty" is a tractor of 4½ tons weight, rated at 30 drawbar horse power, and has been found suitable as a replacement for the Ordnance 5-ton tractor, Model 1917, for use with corps artillery (such as 155-mm. howitzers). The "Sixty," weighing 10 tons, and rated at 50 drawbar horse power, has been found suitable for moving army artillery loads (155-mm. guns) and is a replacement for the Ordnance 10-ton tractor, Model 1917. These tractors have a maximum speed of about 4½ miles per hour. (*Concluded*)



Armored Railway Car Used in the Recent Attack upon Loyang, China.



"Finishing Coast Defense Guns"—The Technique of Nearly a Half-Century Ago.
An artist's sketch published in Frank Leslie's Illustrated Newspaper, December 25, 1886.

The Characteristics of an Explosive

Properties Determined by Combustion in a Closed Chamber

By M. E. Burlot*

THE purpose of this paper is to discuss briefly the experimental method of determining some of the mechanical properties of an explosive by means of combustion in a closed chamber and to describe the characteristics of the apparatus used for this purpose in the laboratory of the Scientific Commission of Explosive Materials (*Commission Scientifique des Substances Explosives*). This Commission was organized by the French Minister of War for the investigation of questions which he deems appropriate to submit for its examination, either directly or at the request of the various services and ministerial departments concerned. The laboratory of the Commission is frequently requested to make experiments capable of furnishing data with respect to the mechanical or ballistic functioning of explosives.

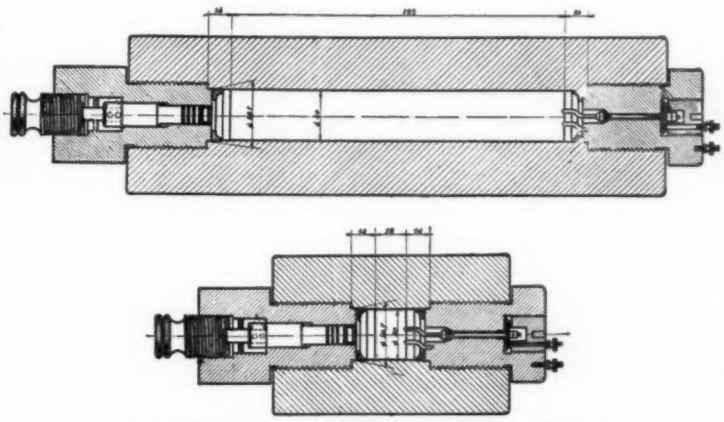


Fig. 1. Cross Section of the 150-cc and 25-cc Eprouvettes with Obturators and Plugs.

Aside from the phenomena of sensitiveness and velocity of detonation this investigation usually includes the determination of: P (t); V_0; T. Although these terms are well known to the reader their definition should be recalled at this point. P (t) is the pressure developed as a function of time by the combustion in a volume "v" of a weight "$\tilde{\omega}$" of explosives; V_0 is the specific volume of the explosive, that is, volume of the gaseous mixture (permanent and nonpermanent gases reduced to 0°C and 760-mm. atmospheric pressure) resulting from the combustion of a unit weight of explosives; T is the average absolute temperature of the gases at the moment of maximum pressure.

These terms are related to each other by the following equations:

$$P = \frac{f\Delta}{1 - \alpha\Delta}\ ;\ f = \frac{P_0 V_0 T}{273}\ ;\ \alpha = \frac{V_0}{1000}\ ;\ \Delta = \frac{\tilde{\omega}}{v}$$

P_0 is the normal atmospheric pressure; f is the theoretical force of the explosive; α is the covolume, and Δ, density of loading.

It is hardly necessary to derive these formulas which result from the application to the products of the combustion of explosives of the equation of Van der Waals-Clausius reduced to its first term.[1]

On the other hand, we should bear in mind that in order to justify the application of these formulas, it is necessary that the elements which compose them participate in the same phenomena of combustion. This means that these quantities should have been determined simultaneously. In the absence of such experimental determination it would be necessary to repeat the experiments a sufficient number of times to reduce the experimental errors as much as possible. It is this consideration which caused the Powder Service to study the apparatus which has now become standard in this Service.

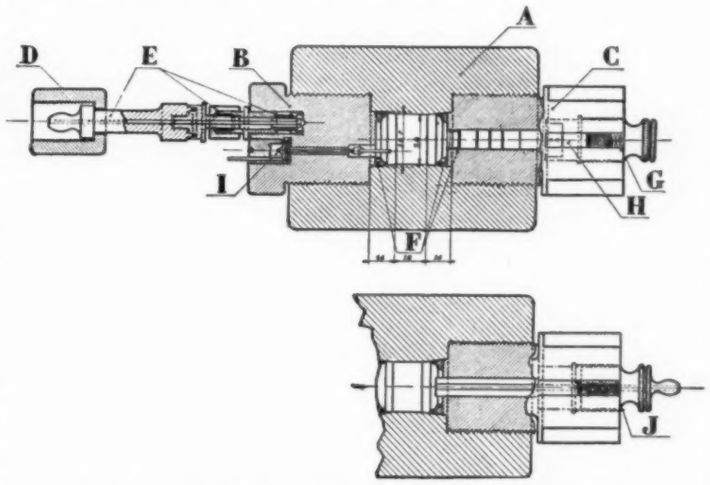


Fig. 2. Special Eprouvette for the Study of Explosives.

A, body of bomb; B, plug containing the needle valve and ignition apparatus; C, plug containing crusher gage; D, union for gas line; E, needle valve with stuffing boxes; F, obturators; G, plug containing anvil for crusher gage; H, crusher cylinder; I, insulated binding post for ignition apparatus; J, tube for admission of water.

LET us say at once that the apparatus used is of well known types, the principles of which have not been modified in any way. A. The pressure gage eprouvette of M. Vieille for the measurement of pressures by means of crusher gages and recording devices; B. gasometer of Sarrau and Vieille for the measurement of V_0; and C. calorimeter of Berthelot for the measurement of the temperatures of combustion.

*Chief Engineer of the Corps des Poudres, Recording Secretary of the Scientific Commission of Explosive Materials, Prize Winner of the Institut de France. This paper was prepared especially by the author for ARMY ORDNANCE and was translated from the French by Maj. Donald Armstrong, Ord. Dept., U. S. Army, Washington.

1 See Sarrau: Introduction to the theory of explosives (Memorial des Poudres et Salpetres).

If the apparatus itself is not new in principle, the models are novel in design. Their characteristics may be described as follows:

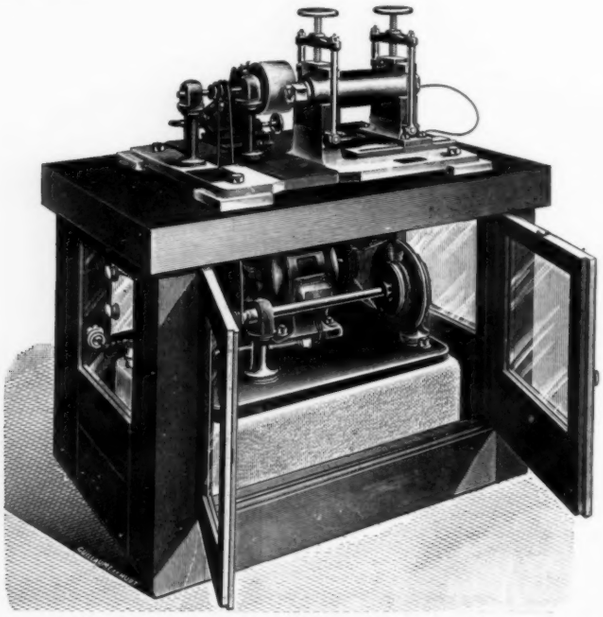


Fig. 3. Installation in the Laboratory of the Commission of Explosive Materials for the Measurement of the Compression of the Crusher Gages as a Function of the Time.

A. Measurement of Maximum Pressure "P"—pressure gage eprouvette.

The specifications for this apparatus were determined so that the following conditions would be fulfilled: 1. To reduce to a minimum the errors of pressures observed when eprouvettes of varying capacity are used; 2. To render possible the correct measurement of pressures up to the extreme limit of the tarage table (4100 kgr. per square centimeter for the crusher 13/8); 3. To allow interchangeability of closing plugs and of obturators of bombs of different capacity; 4. In studying explosives, to render possible within the calorimeter combustion in a closed chamber under variable initial pressures (from pressures of a few millimeters of mercury up to the usual pressures in compressed gas cylinders, that is, 200 kgr.) and to make possible drawing off the gases after combustion.

The method of meeting these requirements is as follows:

1. Comparison of the pressures obtained in eprouvettes of different capacities.

For the same density of loading, cylindrical eprouvettes of different volume do not give as a rule the same measurements of pressure. This condition is caused by the decrease in pressures consequent upon the fall in temperature when the gases are cooled by contact with the walls of the eprouvettes. This cooling varies with the dimensions of the eprouvette, more exactly in the ratio S/V characterizing the combustion chamber, where:

S is the surface and V, the volume of the interior of the chamber.

In the case of cylindrical eprouvettes it can be shown by calculations that S/V is smaller when the diameter D and the length L are greater. The greatest variations of S/V are caused by changes in the diameter. In practice, the limit of D results from the calculation of the resistance of the eprouvette whose exterior diameter should equal at least 3 D if it is desired to measure correctly a pressure of 4000 kgr. The length L is limited by the necessity of assuring the uniformity of pressures along the entire length of the eprouvette.

For these two reasons the most perfect type of eprouvette would be spherical. Because of the difficulties of machining and of obturation the apparatus is built in the cylindrical form but with L equal to D or approximately so, in every case where the powder does not have one dimension which greatly exceeds the others.

Thus, for pulverulent explosives L equals 40-mm.; D equals 30-mm. On the other hand, for powders such as nitrocellulose or nitroglycerin propellants we have taken L equals 196-mm.; D equals 30-mm.

2. Size of the limiting pressure.

It is a necessary condition that the eprouvettes should be able to withstand without appreciable deformation the highest pressures compatible with a proper utilization of the crusher. The compression of the crusher should not exceed 50 per cent of its initial height if the correctness of the measurements is not to be endangered. These limiting pressures, as regards the crusher 13/8, are 4000 kgrs. for a piston whose cross section is one square centimeter. This condition is moreover desired as it implies both the safety of the apparatus and the correctness of measurements for which it is designed, aside from the damage which might result for the obturators from higher pressures.

Without going into detailed calculations or entering into a discussion of the hypotheses on which they are based and which will shortly be published elsewhere (*Memorial des Poudres*) we can state that: 1. The factor governing the limit of use of the eprouvettes is not the thickness of the walls measured from a minimum but the elastic limit of the steel of which it is made; 2. There is no major advantage in taking a thickness of tube greater than the diameter of the bore, and 3. On the other hand, the homogeneity of the tube from the point of view of its mechanical characteristics is more difficult to obtain when the diameters become larger.

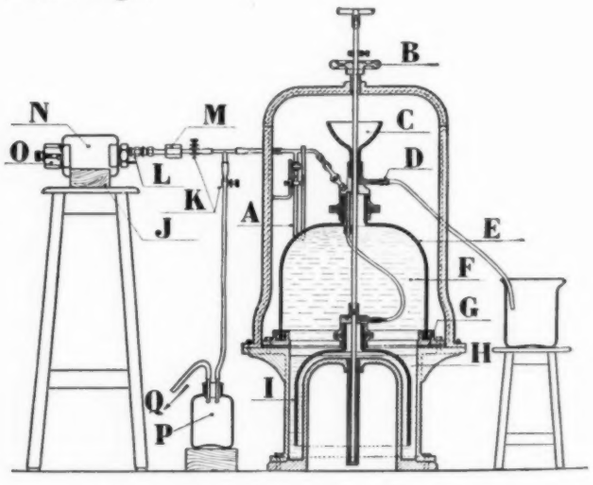


Fig. 4. Cross Section of the Sarrau and Vieille Gasometer.

A, pressure gage in open air; B, operating hand wheel; C, funnel for filling the glass bell; D, overflow; E, fixed glass bell; F, distilled water; G, tallowed surfaces; H, mercury; I, movable glass bell (gasometer); K, clamps; L, needle valve; M, union; N, bomb; O, plug with crusher gage; P, safety bottle; Q, to the vacuum pump.

IT is just as important that the steel should be homogenous as it is essential that, after machining, the internal surface of the eprouvettes should be perfectly polished and should have no incipient cracks, no matter how small they might be. These considerations have fixed the dimensions of our eprouvettes. (Fig. 1.)

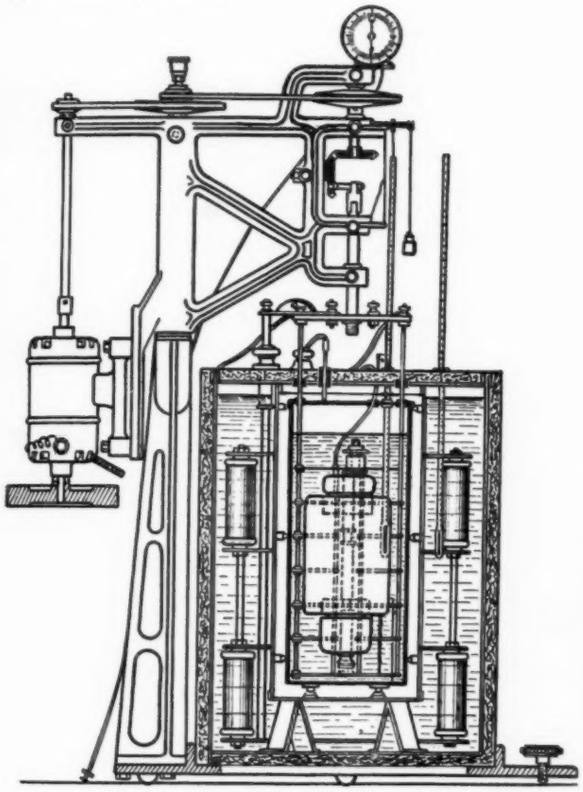


Fig. 5. Landrieu Malsallez Calorimeter for the Study of Explosives.

One of these (No. 28) has been tested in the laboratory of the Scientific Commission of Explosive Materials with successive hydraulic pressures of 4400, 4800, 5250, and 5450 kgr. without showing any appreciable change in dimensions. It is particularly noteworthy that the registering piston machined from the same metal as the body of the eprouvette was able to withstand these pressures without a permanent set or damage of any kind. Our Piezo-electric gage unfortunately limited our tests to pressures not greater than 5450 kgrs.

3. Interchangeability of plugs and obturators for eprouvettes of different capacities.

This condition has been fulfilled by a careful inspection of the material by means of ring and plug gages machined with a high degree of accuracy, on the basis of the international meter at a temperature of 0°C.

4. Special eprouvette for the study of explosives. (Fig. 2.)

The steel of this eprouvette must be resistant to the gases resulting from the combustion of the usual powder and explosives, under conditions of temperature, pressure and time obtained during these combustions.

As regards its dimensions, the necessity of having in the closing plug with the ignition apparatus, a needle valve to introduce or remove gas from the eprouvette caused an increase in diameter of the plugs and consequently of the screw threads. This increased the strength of the eprouvette which was advantageous since the apparatus eventually has to be placed in a calorimeter, a device which must be safeguarded from all explosions.

The closing plug with the crusher gage is designed to admit a special tube for the introduction of water into the eprouvette after combustion, using a method developed by the laboratory of the Commission. The description of this apparatus will be found in the *Memorial des Poudres.*

B. MEASUREMENT OF P (t):

The measurement of P (t) is carried out by registering the compression of the crushers as a function of the time. To this end the piston of the crusher gage has a pen which inscribes its movement on a cylinder covered with lamp black at the same time that the cylinder is marked by a tuning fork. The respective positions of the eprouvette, of the recording cylinders and of the tuning fork are shown in Fig. 3.

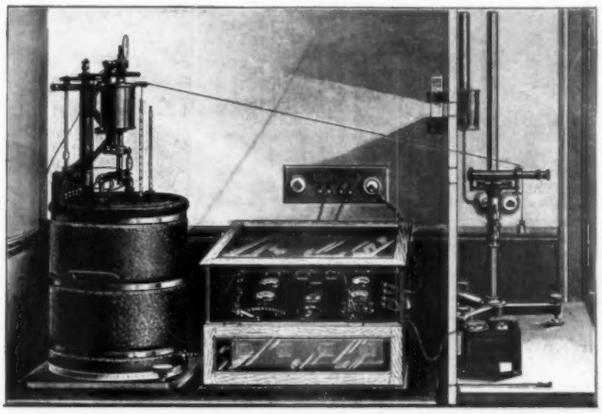


Fig. 6. Explosive Calorimeter. Installation in the Laboratory of the Commission of Explosive Materials at Sevran.

This recording apparatus is not constructed to synchronize the measurement of time by the tuning fork and the measurement of pressure by the compression of the crusher. Consequently, in order to measure the duration of combustion, it is necessary that the recording cylinder should have a rigorously uniform movement. We have attained this result without adding more or less complicated and delicate adjustment apparatus. It has sufficed, and experience has confirmed our views on this subject, to make the moving parts supported on ball bearings (the armature of the motor, the pulley of the intermediate transmission, the recording cylinder) sufficiently heavy so that the inertia of the assembly prevents an appreciable variation in speed of rotation during the short interval of time (of the order of the second) necessary to record the phenomena (the compression of the crushers and the recording of the time).

It is equally important to note that the power of the motor is much greater than is absolutely necessary to rotate the moving parts. This excess of power as well as the fact that electrical energy taken by the motor is a very small portion of that available in the circuit contribute also to assuring a constant speed of rotation during a short interval of time. As a matter of fact the points made by the tuning fork at 10-second intervals during a period of five minutes gave, for a time interval whose average value was

1/500 of a second, a mean arithmetical error considerably less than one per cent. The average errors are both positive and negative without systematic distribution capable of indicating a regularly accelerated or retarded movement of the cylinder.

C. Measurement of V_0:

The measurement of V_0 is facilitated and at the same time is rendered extremely accurate by means of the needle valve in combination with the ignition apparatus with which the eprouvette for the study of explosives is supplied. This needle valve is joined to the Sarrau and Vieille gasometer which is described in the *Memorial des Poudres* (Vol. 2, pages 137, et seq.). Fig. 4 shows how this junction is made.

D. Determination of T.

The determination of T may be carried out in two different ways.

1. Having measured P for a density of loading Δ given by an explosive whose covolume $\alpha = \frac{V_0}{1000}$ is known, f is computed by means of the formula:

$$f = \frac{P}{\Delta} - \alpha P$$

and consequently

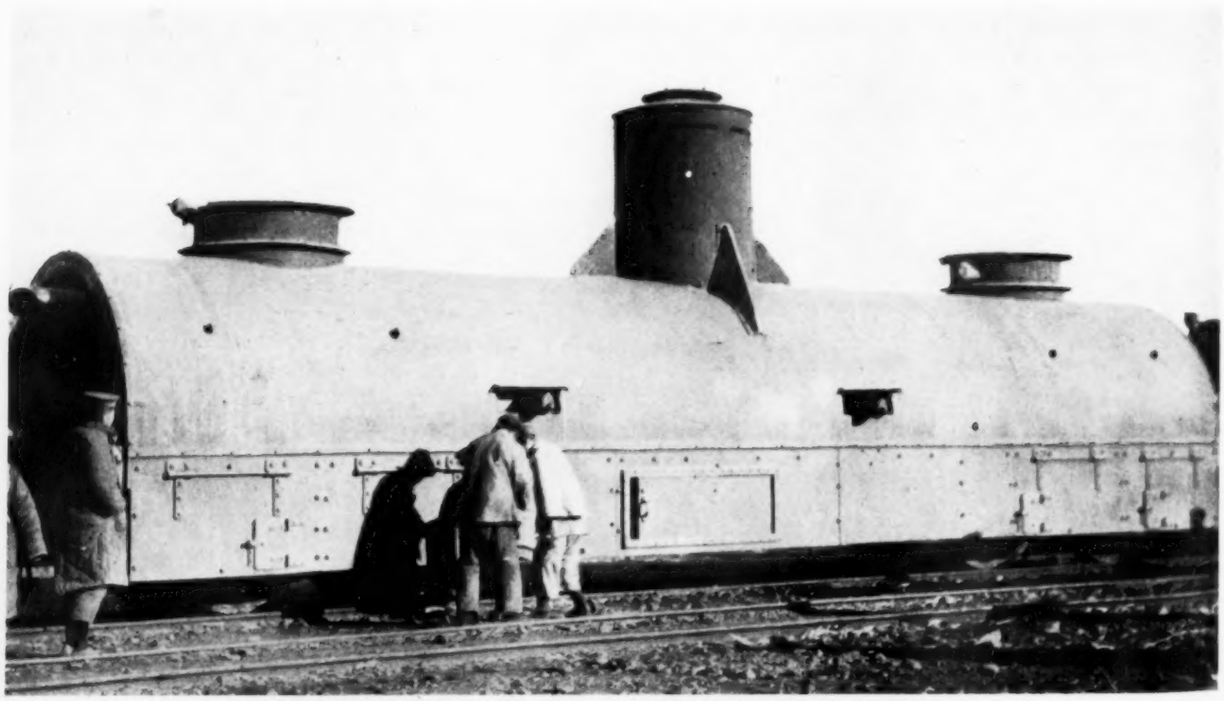
$$T = \frac{273\ f}{P_0 V_0}$$

Experimentally the determination of T by this method reduces consequently to the measurement of P and V_0.

2. After measuring Q (temperature of combustion) in the calorimeter and after analyzing the explosive and the products of its combustion, it is possible to write the equation of combustion from which the equation of maximum pressure is derived taking into consideration the phenomena of the dissociation of condensed gaseous molecules (CO_2, H_2O) at high temperatures and pressures as well as the secondary reactions which alter the equilibrium of the maximum pressure during the period when the gases are being cooled (formation of methane). This equation of equilibrium being written, a method of simple calculation based on the knowledge of the specific heat of the gases leads to an equation of the second degree whose solution gives the value of T (*Memorial des Poudres,* Volume 2, pages 442 et seq.).

It is then necessary to immerse the eprouvette in the calorimeter. This fact has been taken into consideration in calculating its dimensions. The calorimeter used differs from the Landrieu Malsallez type, shown in cross section in Fig. 5, which is used at the College de France and in a large number of French and foreign scientific laboratories, only in the dimensions of the calorimetric container. The amount of water is sufficient so that the eprouvette being completely immersed, it would be possible to measure with a satisfactory approximation the quantities of heat given out by the combustion of the explosive. The results are good for the smallest densities of loading (corresponding to pressures of 1000 kgrs.) up to high densities of loading (pressures of 4000 kgrs.) as well as for explosives with a very weak potential (black powders) and for those having on the contrary a high potential (dynamite).

These measurements require, other things being equal, a high degree of accuracy in reading the thermometer. As a safety measure the thermometers must be read from a distance with the protection of a screen consisting of a strong steel plate. Consequently, particular care must be exercised in installing the calorimeter, in both the ignition and in the reading apparatus. Fig. 6 shows how this installation has been made in the laboratory. With this apparatus we measure currently the potentials of explosives to $\pm$ 1/1000.



An Armored Railway Car used by the Nationalist Forces in China.

Army Ordnance During 1930

Extracts from Annual Report of Maj. Gen. Samuel Hof

EXTRACTS from the annual reports of the heads of the Army and Navy ordnance organizations furnish a fair compendium of current American munitions advancement. On this and the following pages are published excerpts from the reports of the Chief of Ordnance, U. S. Army, and the Chief of the Bureau of Ordnance, U. S. Navy. Both reports were recently made public and are for the fiscal year ended June 30, 1930. While references to the more important activities only are extracted, they are sufficiently comprehensive to indicate the satisfactory progress of American ordnance material during the past year.

SATISFACTORY progress has been made during the year in the centrifugal casting program. The 37-mm. infantry mortar, 37-mm. gun, and 75-mm. howitzer have been produced by this method. Both the infantry mortar and the 37-mm. gun have been exhaustively tested at the Aberdeen Proving Ground with satisfactory results.

Pursuant to general invitation issued by the Department, the following weapons were submitted to the Board on Semiautomatic Rifles, for test to begin July 1, 1929; Browning, Colt, U. S. Model T3 (Garand), Czechoslovak, U. S. Model T1 (Pedersen), Thompson (two types), Rheinmetall and White. Of these all were tested except the last named, which was submitted in an uncompleted condition after the tests were closed. As a result of the tests the board recommended that 20 rifles, caliber .276, U. S. Model T3 (Garand) be manufactured and subjected to further tests. The board also recommended that a rifle of the U. S. T3 design, but of caliber .30, be manufactured, to determine the possibility of obtaining a weapon of this caliber, within the weight limit, which would meet requirements with respect to functioning. These rifles are in process of manufacture and are expected to be ready for test at an early date.

Two antiaircraft multiple machine gun truck mounts, designed to afford protection for marching troops, have been constructed and will be tested during the antiaircraft exercises to be held this fall. One mount is equipped with four caliber .50 machine guns and full automatic fire control, including a director and height finder mounted on a firing platform which, in turn, is mounted on a truck, and is capable of being quickly leveled, both transversely and longitudinally. This mount represents the ultimate in mechanical equipment for accurate machine gun fire. The other mount is equipped with two caliber .50 machine guns and a stereoscopic sight by means of which the line of fire, as seen from tracers, can be directed to the target. The mount has been constructed principally by welding so as to insure minimum weight. A new automatic feed mechanism is provided, and each gun is equipped with an ammunition box capable of holding 1,200 rounds in a continuous belt. This mount represents the simplest type of fire control yet developed for a multiple mount.

As a tank, when under way, is at best an unstable gun platform, it is important that weapons of a high rate of fire be employed so that the gunner may, when his gun is on the target, fire a number of rounds very quickly. For this reason the development of a semiautomatic 37-mm. gun was undertaken. During the year an experimental 37-mm. semiautomatic gun of 2,000 f. s. velocity, has been completed and successfully tested. There was also set up a requirement for a larger semiautomatic tank gun—a 3-pdr. or 1.85-inch gun. During the year such a gun was developed, using largely material on hand. Test of this gun shows it to be a successful development, and a great step forward in tank weapons. This gun is now installed in the new medium tank being tested.

A new 37-mm. antiaircraft mount has been designed and will be available for test during the 1930 antiaircraft exercises. The new mount is principally of welded construction, and embodies those features shown to be desirable and recommended as a result of the test of a previous model during the 1928 antiaircraft exercises. Two of the previous model will be modified to take the Sperry data receiver and, with the new model, will constitute a 3-gun battery for test during the 1930 antiaircraft exercises.

Tests of the 75-mm. mortar (smooth bore) have progressed to the point where all the elements of this matériel have been determined, except the size of the powder chamber. One unit, having a new design of breech mechanism, a new elevating mechanism, strengthened trail, and improved means for securing the piece in traveling position, is undergoing test at the proving ground. Completion of 16 units of this matériel during the coming fiscal year is contemplated.

Twelve units of the 75-mm. pack howitzer have been issued to the service in the Canal Zone and two to Fort Robinson, Nebraska; six units are being manufactured for the Navy. Two of the units, of experimental type, which were under test at Fort Robinson, have been returned to Rock Island Arsenal for modification in accordance with the latest design of pack transportation. This new matériel is adapted for packing on either the aparejo or the Phillips pack saddle. Pack load accessories have been designed, tested, and adopted, and are being manufactured in sufficient quantity to supply the Canal Zone and Fort Robinson. An instrument pack for carrying fire-control equipment has been designed, tested and adopted, and 16 units have been ordered manufactured. Ammunition packs for carrying the new ammunition have been designed, and two proposed methods will be given service test at Fort Robinson during the coming fiscal year.

THE Caliber Board outlined the requirement for a division carriage having all-round fire and a vertical arc of fire of from minus 5° to plus 80°. During the past year the

Ordnance Department has designed and built two such carriages. The gun and recoil mechanisms for these carriages were taken from the 75-mm. gun carriage M1925 and modified, the gun having a counterweight added, and the recoil mechanism being provided with a variable recoil device. Both carriages have been given preliminary tests at Aberdeen Proving Ground; after certain modifications these tests will be completed, after which the carriages will be turned over for service test by the Field Artillery Board.

Six units of the latest model 3-inch mobile antiaircraft mount have been manufactured and issued to the service. Four of these units were tested during the 1929 antiaircraft exercises. The original design of these mounts contemplated the use of steel castings for important parts; but sound castings were difficult to obtain, and welded construction has been adopted. Welded carriages have been tested with satisfactory results. This type of construction makes for a lighter and stronger mount. Twelve units are now under manufacture using the welded type of construction. One set of outriggers, of welded construction, is under manufacture for test during the 1930 antiaircraft exercises. Outriggers, at present, are made up of aluminum alloy castings, which are both difficult to produce and expensive. Six 3-inch antiaircraft guns for these mounts have been manufactured and issued to the service. Twelve additional units are now under manufacture. This design permits of the use of interchangeable liners.

The latest models of both the 3-inch mobile and the 3-inch fixed antiaircraft guns are now manufactured with sufficient clearance between liner and tube to secure interchangeability. Improvement in design has practically eliminated scoring of the exterior surface of the liner when removing it from the tube.

WHILE mechanization is a general term relating to the use of machinery to augment the fighting power of troops and to reduce greatly their casualties, the question of mechanical transport is almost always involved and is usually the crucial element in the equipment and therefore, in a particular sense, mechanization applies to the development of automotive fighting vehicles. In the summer of 1928 a small experimental mechanized force was assembled at Fort Geo. G. Meade, using all the available equipment, most of which was old. The lessons gained from this experiment were principally that high speed, great reliability, cross-country mobility, and great fire power are required in mechanical fighting vehicles. Since that time these lessons have been applied to the limited amount of automotive development being carried on by the Ordnance Department. The Secretary of War has recently approved the report of the War Department Mechanization Board, with the general result that a small mechanized force will again be assembled in the fall of 1930. This force will be equipped with the best of existing experimental and other vehicles, plus new vehicles to be built from a special fund of $239,855.00, appropriated by Congress for the fiscal year 1931. From an engineering standpoint such mechanized vehicles, including tanks, as have been developed by the Ordnance Department in the last few years have been very successful developments, measured by these facts: 1st. The vehicles produced are much better than the ones made before, and, 2nd. The vehicles produced are the equal, and in many cases they are superior, of similar types produced abroad.

The four medium and two light wheeled armored cars furnished to the Cavalry in 1928 have been undergoing extended service tests by the 1st Cavalry Division. As a result of these tests the bodies of the medium cars have been modified so as to embody light turrets. Other minor changes also have been made. Reports indicate that the medium cars have been particularly successful, and are in excellent condition after running considerably more than 10,000 miles, much of which was in actual maneuvers.

The Caterpillar "20" tractor completed its Ordnance Department and service tests and, upon the recommendation of the chiefs of the interested and using services, was standardized by the War Department as the light artillery tractor. The Caterpillar "30" and "60" tractors were previously standardized. This action results in the completion of standardization of a line of commercial track-laying tractors. The 2-ton tractor previously standardized was transferred to limited standard. Tests of representative commercial tractors were continued at Aberdeen Proving Ground, in order to keep the Department informed of new developments.

An antiaircraft multiple machine gun truck was developed and delivered to the proving ground for test. The chassis of this vehicle is a 6-wheeled 4-wheel drive commercial truck of about 2 tons capacity. Welded steel tracks to fit the tires of the four driving wheels have been developed for use when off the road. Preliminary tests at the proving ground indicate that this type of track will greatly increase the cross-country ability of this vehicle, if it is properly handled.

The question of furnishing the Army with a tank of convertible wheel and track laying type is again under consideration. This is a vehicle which operates on wheels like a heavy truck when moving on improved highways to which a track can be applied for use in negotiating bad roads or terrain inaccessible to a wheel vehicle. Such a vehicle designed by Mr. J. Walter Christie was loaned to the Cavalry for test with a view to its use as a heavy armored car. As a result of this test, which was of limited scope, the Chief of Ordnance was directed to procure one of the vehicles equipped as an armored car for the Chief of Cavalry. After investigation and the preparation of detailed specifications, it became apparent that the Christie vehicle, when fully equipped as a fighting tank, would have a weight at least 50 per cent greater than that of the chassis tested. It was therefore decided to negotiate with the U. S. Wheel Track Layer Corporation (the manufacturer of the Christie vehicle) for one Christie tank for extended tests by the Infantry and Ordnance Departments.

In the summer of 1929 a contract was entered into for the manufacture of one medium tank of 15 tons weight, according to a design prepared by the Ordnance Department. Due to priority of other work, actual manufacture was not begun until late in 1929. This tank is now nearing completion and will soon be ready for shop test. It is designed to be one of the most powerful fighting tanks ever built, with a maximum speed of 25 miles per hour, and equipped with two heavy guns and 2 machine guns. In the manufacture of this tank extensive use has been made of electric arc welding.

From studies made of the generation of charges of static electricity in the blending of smokeless powder it has been ascertained that when the relative humidity of the atmosphere is 60 per cent or more, the static charge accumulated by the powder is negligible. Further studies are being made.

Naval Ordnance During 1930

Extracts from Annual Report of Rear Adm. William D. Leahy

FUNDS were appropriated and allotted for the fiscal year 1930, as follows:

Act of Mar. 2, 1929:	
Ordnance and ordnance stores	$11,669,400
Purchase and manufacture of smokeless powder	1,000,000
Torpedoes and appliances	450,000
Civilian employees of the bureau	157,620
Increase of the Navy, armor, armament, and ammunition	17,800,000
Allotments from appropriation under the Secretary of the Navy:	
Contingent expenses, Navy Department	2,000
Printing and binding, Navy Department	13,000
Total	31,092,020

During the past year there was completed a comprehensive survey of all United States ordnance patents which the Government had a right to use in its manufacturing or development projects. The compilation consists mainly of a terse statement of the gist of the invention and a record of the conditions controlling the Government's use, i. e., whether royalties were payable or whether the patent could be used without an accounting. These data have been printed and distributed to all stations interested in the development, repair, or maintenance of ordnance material, thus making available to the field forces the full resources of new ideas open to use by the Government. When a station has reason to believe that a patent listed may be of service in the course of a project under consideration, it is intended that the complete patent shall be studied and data obtained from the bureau giving the details of the terms under which the invention may be used, if agreements are in effect.

Progress has been made in preventing patent litigation arising out of the ownership of patent rights in development work financed by the Government but performed to a greater or less extent by contractors. Questions of patent rights are now definitely brought up and settled in advance to the satisfaction of both parties.

The collection of both historical and current data for the defense of the Government in connection with patent suits occupies a considerable portion of the time and energies of the patent section. It is hoped, with the settlement of pending suits and the prevention policies now in effect, that a larger portion of time may be devoted to the constructive work of securing patent protection for inventions initiated by the bureau.

FIVE-INCH 25-caliber antiaircraft guns and breech mechanisms have been ordered for cruisers 37 and 38 and for the *Pennsylvania* and *Arizona*. Work on 8-inch 55-caliber and 5-inch 25-caliber batteries for the *Augusta, New Orleans, Portland, Astoria, Indianapolis,* and *Minneapolis* is progressing at a satisfactory rate. The first of the 16-inch gun ships, the *Maryland,* has been regunned during the year and the work of relining eight 16-inch guns removed from the *Maryland* is in process at the Naval Gun Factory. The *Mississippi* was in June, 1930, provided with relined 14-inch 50-caliber Mark VII guns. Routine regunning of 4-inch 50-caliber batteries of destroyers and of 4-inch 50-caliber wet type guns on submarines has been started.

After competitive bidding, contracts have been awarded to the Bethlehem Steel Company for forgings for a type 8-inch 55-caliber Mark XII gun and for use in relining guns during the fiscal year 1931. An experimental battery of two 5-inch 25-caliber antiaircraft guns has been placed on the U. S. S. *Gilmer* for test.

Three-inch antiaircraft and 4-inch guns and mounts are in process of being converted to wet type for installation on submarines.

During the year fourteen 8-inch 55-caliber guns were manufactured and in addition five 8-inch 55-caliber guns from Watervliet Arsenal and four 8-inch 55-caliber guns from the Midvale Company were fitted with breech mechanisms and completed at the Naval Gun Factory, making a total of twenty-three 8-inch guns completed. Forty-six 5-inch 25-caliber guns were also manufactured at the Naval Gun Factory. In addition, the Naval Gun Factory lined, relined, or modified eighteen 14-inch, two 8-inch, two 6-inch, forty-three 5-inch, and thirteen 4-inch guns. All 12-inch and 8-inch guns and breech mechanisms held for the United States Army have been transferred to the Army. Upon the disposal of three battleships in accordance with the terms of the London Treaty there will in addition be available for transfer to the Army sixty-three 12-inch guns with ammunition.

Modifications have been made in the fuze setter of 5-inch antiaircraft mounts by decreasing the weight, and by bracing, to steady the fuze setter on the platform.

Deliveries of 5-inch 25-caliber antiaircraft mounts were made to the *Chester, Houston, Louisville, Chicago,* and *Augusta.* It is expected that the battery for the *Pennsylvania* and *Arizona* will be delivered by September 15 of this year. Experimental installation of two 5-inch antiaircraft mounts on the *Gilmer* has been made during the year. Conversion of three 3-inch 50-caliber antiaircraft mounts to wet type and the modification of two 4-inch destroyer mounts, Mark XII-3 to 4-inch wet mounts for installation on submarines have been started.

A CALIBER .50 single antiaircraft machine gun type mount has been completed and is now under test at the naval proving ground. If this mount proves satisfactory, work will proceed with its manufacture for installation on all cruisers now under construction and on the *CV-4.*

The bureau is proceeding with the completion of manufacturing drawings for the construction of two type machine guns of larger caliber for use against aircraft. It is expected that these guns will be completed and ready for test about April 1, 1931.

No armor under the cognizance of the Bureau of Ordnance was manufactured during the past year. Tests have been made in connection with the revision of specifications for light armor. These revised specifications will apply to armor which it is expected to obtain during the fiscal year

1931 for new light cruisers. Tests have also been made of the absorption of projectile energy by light armor and these data will be available for use in the design and distribution of protective plating for new construction.

The naval powder factory has operated continuously throughout the year with the following output:

	POUNDS
New powder	1,952,359
Reworked powder	359,044

In addition, a small quantity was purchased from commercial sources at a price slightly less than the total cost of manufacture at the naval powder factory. It is considered necessary to keep commercial sources available to meet wartime demands. All small-arms ammunition with the exception of some special and training types was purchased from the Army. Reworking old powders, blending powders, and reassignments of obsolete powders to active calibers have been continued and have resulted in considerable saving.

Purchase and manufacture of smokeless powder produced about a half-million pounds less than the annual target practice expenditures. This figure does not accurately represent the actual decrease in our stock of serviceable powders as a number of obsolete granulations are being expended in target practice for reduced charges in turret guns, and most of the powder withdrawn because of age and instability was of obsolete granulations.

The breakdown and overhaul of assembled ammunition on hand is being continued as rapidly as is practicable with the facilities and funds available. All water-dried powders have been ordered withdrawn from the service allowances of vessels and will be used for target practice. This withdrawal is nearly complete.

Experiments have during the year been conducted with a nonvolatile solvent powder produced by the Du Pont Company, which the producers believe will materially lengthen the stable life of powder, and another year should permit of reaching a decision as to the value of its adoption for certain naval purposes.

Restowage of material at depots and stations to conform to the requirements of House Document No. 199 has progressed continuously throughout the year. The naval ammunition depot at Hawthorne, Nev., should be completed in October, 1930, at which time shipments of explosives from other depots will start.

Progress toward the replacement of existing storage facilities at Pearl Harbor and Cavite, recommended in House Document No. 199, has been delayed by difficulties encountered in acquiring title to the necessary land. This land is now in process of condemnation and it is hoped that actual construction work on the storage facilities can commence within a year. New safe shell storage at the naval magazine at Mare Island now under construction will be completed in a year and will relieve the existing very unsatisfactory congestion of explosives at that magazine. Four new powder magazines and two buildings for shell storage completed at Lake Denmark during the year will improve congested storage conditions at Fort Mifflin and at Iona Island.

Considerable improvement in safety has been made at all naval ammunition depots during the year by the survey and removal of all the obsolete aircraft bombs left over from the World War and by a redistribution of the powder and explosives in storage.

Experiments on pyrotechnics have been continued, and progress has been made toward a satisfactory design of flares and signals.

THE modernized fire-control systems of the *Oklahoma* and *Nevada* and the main battery and antiaircraft fire-control systems of the *Salt Lake City* and *Pensacola* have been installed and have passed satisfactory shipboard tests.

Work has progressed satisfactorily on modernized fire-control systems for the *Arizona* and *Pennsylvania* and on the fire-control installations for the *Northampton, Chester, Louisville, Chicago, Houston,* and *Augusta.*

During the year a new rangekeeper, Mark VII, was designed to replace the Mark II rangekeeper, and a contract let for 30 of these instruments, 4 each for the *Pennsylvania* and *Arizona* for control of the secondary battery, and 22 for light cruisers 26 to 36 (2 per ship) for use as an auxiliary control of the 8-inch battery.

Catapults, Mark VI, have been installed on all battleships which can take these catapults, except those ships which are to be modernized and the U. S. S. *Colorado.* One is available, for issue to the *Colorado* and it will be installed at the same time with a new airplane power-handling boom. Provision has been made for catapults of this type on all 10,000-ton cruisers. The work of manufacturing catapult guns, assembling these guns to the structures, and testing the assembly is continuing at the Naval Gun Factory.

A blast reducer has been designed for both the turntable type and turret type catapults. The turntable type blast reducer has been tested at the Naval Gun Factory, and a project order issued to equip all present catapults now in service with these blast reducers. A project order has also been issued to manufacture blast reducers for turret type catapults which will be installed as soon as the material is ready.

The gun camera situation during the past year has shown steady improvement. Existing cameras have been modified with considerable improvement in both functioning and results, and a new type camera, recently developed, is now being received from the contractor and delivered to service units.

Efforts directed toward the development of aircraft machine-gun mounts suitable for the rear cockpit of high-speed observation-type airplanes have continued throughout the year. In order to complete this development both commercial and service organizations have been encouraged to design, complete, and test various types of mounts with the idea that eventually a satisfactory type may be evolved from one of the designs submitted, or from a combination of different features of the different designs submitted.

Study of bomb rack design has been continuous during the year and in all designs an attempt is made to inclose more and more of the bomb rack within either the fuselage or wing of the airplane with the purpose of keeping the drag from this equipment at a minimum.

Two types of smoke-screen equipment are now standardized, one to be carried on the fuselage and the other in bomb racks under the wings of lighter type airplanes. There is also under development a type of smoke-screen equipment adapted for efficient use on heavy type airplanes.

EFFORTS of the design section of the bureau have been principally directed toward work on the improvement and completion of designs of ordnance for new construction and for modernized battleships, which work is progressing at a satisfactory rate. With the force of designers and draftsmen that can be employed with the limited funds available the progress of new design is slow.

During the year some progress has been made on studies of lighter 8-inch guns for cruisers, improved protection for 8-inch mounts, machine guns of different calibers for antiaircraft defense, new multiple mounts and increased sustained rate of fire for 6-inch guns, multiple mounts for antiaircraft guns, improvement of torpedoes for both surface vessels and aircraft, and improvement in the design of aircraft bombs and bomb fuzes.

As reported last year there is need for an increase in the design force to permit orderly progress toward the solution of many problems in ordnance design that are now before the bureau.

Experimental and research work and development have during the year been conducted as actively as was permitted by the funds available, utilizing the facilities that are under the supervision of this bureau and receiving valuable assistance from the Naval Research Laboratory, the Bureau of Standards, the technical staff of the Army Ordnance Department, the Chemical Warfare Service, and from commercial manufacturers of explosives, of metal products, and of electrical equipment.

Some of the problems studied by experimental and research methods during the year were improvements in projectile and bomb fuzes, aircraft flares and signals, smokes and smoke-projecting apparatus, bombs for target practice, torpedoes, optical instruments, tracers, pyrotechnics and explosives.

The naval torpedo station, Newport, R. I., has continued the modernization and conversion of torpedoes in accordance with programs authorized by the bureau. Manufacture of new torpedoes for vessels under construction has progressed throughout the year, as well as the manufacture of replacement torpedoes up to the limit of funds available. Methods of planning and progress of work in the maintenance department have resulted in economical expenditures of funds. Worn-out power plant machinery has been replaced as funds permitted. Installation of modern machine tools and the use of improved cutting-tool materials have increased the volume, reduced the cost, and improved the quality of the work.

A survey of the personnel situation with respect to the requirements of various operations has during the year resulted in an improved distribution of skilled and unskilled labor and has lowered the cost of production. The labor requirements for the assembly of gyros and their mechanisms have been lower than for any previous year for the same output. In the primer department, regrouping of machines, increase in tool speeds, and improved tool preparation resulted in more than doubling the output.

The Pacific coast torpedo station, Keyport, has continued the conversation and modernization of torpedoes, using material for that purpose supplied by the naval torpedo station, Newport. An electroplating plant has been completed, and interiors of flasks and water compartments of torpedoes under conversion, as well as of torpedoes from vessels of the Battle Fleet, have been electroplated. The manufacture of igniters was commenced and issues of igniters to vessels of the Battle Fleet have been made during the year.

THE Naval Gun Factory is in good physical condition; it has sufficient capacity to manufacture guns and mounts for all new construction contemplated at the present time. The personnel is skilled and efficient, and the cost of production is satisfactory as compared with previous years.

Due to the completion of a large part of the ordnance for new construction and a reduction in the cruiser-building program there has during the year been a reduction in the number of employees from 4,756 on June 30, 1929, to 4,362 on June 30, 1930. It is estimated that decrease in the work load will in the next half year necessitate a further reduction of about 200 employees. Every effort is being made to predict the work load and in so far as it is within the control of the management, to maintain a steady flow of work through the shops, to stabilize the number of employees, to reach the maximum economy of expenditures for labor, and to avoid discharges incident to variation in the work load.

The Naval Powder Factory has operated continuously throughout the year at an average output of 7,750 pounds per day. In addition to the manufacture of powder, the powder factory blended for target practice for the Navy 1,904,539 pounds of powder of various calibers. Improved lightning protection has during the year been installed on two magazines and on the dehydrating house.

A large quantity of scrap material, representing the accumulation of many years, has been disposed of by sale during the year and the general appearance of the station has been greatly improved by its removal.

There are at the Naval Powder Factory 100 dwellings erected during the World War by the Housing Corporation and subsequently transferred to the Navy Department. There are also 112 dwellings built during the war by the Navy Department for civilian employees. Of this number 167 were rented on June 30, 1930, to employees of the powder factory and other civilians. During the year a total sum of $33,359.33 was received in payment of rent for this property.

The Naval Proving Ground fired a total of 9,940 rounds of all calibers from caliber .30 machine gun to 16-inch 45-caliber guns. The total amount of powder expended was 191,122 pounds. This was an increase of 4,885 rounds fired and a decrease of 54,565 pounds of powder expended in the fiscal year 1929.

An aviation unit forms an integral part of the naval proving ground organization. During the year this detail put in 655.4 flying hours without accident or injury to personnel or planes. Flights made were for acceptance tests of aviation ordnance material, altitude flights to determine atmospheric conditions, experimental and routine tests of aviation ordnance, and transportation flights.

The Navy mine depot during the year has made an experimental study of methods of loading bombs and mines and of preparing and handling explosives in preparation for the loading operation. It is believed that valuable progress has been made toward standardizing methods that will insure reliability of performance of the output and result in greater economy and safety in the loading operations.

Defense Strongholds of Other Days

An Old Russian Blockhouse at Sitka, on the West Coast of Baranof Island, Alaska.

The Greatest Remaining Relic of Medieval Fortresses, the Walled City of Carcassonne in Southern France.

Static Charges in Smokeless Powder

The Generation of Electricity During Manufacturing Operations

By H. E. Nash*

IT has been noted by operating men connected with the manufacture of nitrocellulose powder that dry powder is capable of developing an appreciable static charge. Some have maintained that the discharge of this static can ignite powder and in some cases fires in dryhouses have been ascribed to this cause.

The appearance of static on powder is said to have been observed in trays of powder in the dryhouse through which a current of warm air was passing. Presumably the passage of air was responsible for the static. Mechanical agitation of the powder also occurs during the drying operation with the consequent likelihood of the appearance of static from this cause.

An investigation was undertaken to measure the amount of static electricity accumulating on smokeless powder, particularly E. C. powder, both when at rest and when agitated, and to determine the effect of variation of the velocity, humidity and temperature of the air, and the moisture content of the powder. From these data an estimation was made of the possibility of dryhouse fires being due to static. To aid in this estimation the ability of a static charge to ignite small quantities of powder was measured under varying conditions of moisture content of the powder and with different intensities of spark.

THE inconvenience and danger of conducting tests in the operating dryhouse made it advisable to construct an experimental unit consisting of one standard size tray about 36 x 48 x 6 inches, holding about one hundred pounds of powder. The incoming drying air was forced up through the wire netting and cloth bottom of the tray of powder and could be varied at will relative to velocity, temperature and humidity.

To determine the amount of static existing on the powder its potential was first measured. This was accomplished by means of an aluminum foil electroscope connected to a 6 x 6-inch small mesh copper screen. The screen, originally at zero potential, was lowered in a horizontal position directly on to the surface of the powder and the electroscope reading noted. The potential of the powder was lowered by the introduction of the screen into the region of the powder to be measured; but there is good evidence to believe that the lowering of potential was not large, as was indicated by the following experiment.

When the screen was shunted by a condenser of the order of 0.0005 mfds. capacity and then lowered on the powder, the potential of the screen rose rapidly as it was lowered. After lowering the screen there was continued increase in potential at an unmistakably slower rate, until the potential of the screen had increased to several times its original amount. The explanation for this phenomenon was that when the screen was brought quickly into the field of the charges on the powder its potential was raised and the potential in the vicinity of the screen was lowered to the same value as that of the screen. There was, therefore, a potential difference established between the powder not in the vicinity of the screen, and the screen and adjacent powder. A slow flow of charges then took place until the potential of the screen became equal to that of the nearby powder. If the capacity of the screen had been very low so that its presence in the vicinity of the powder did not materially affect the potential of the powder, there would have been no flow of charges. Actually, when the capacity of the screen was made as low as possible, i. e., when the shunted condenser was removed, the creep in potential did not amount to more than a few percent of the original voltage. Therefore the conclusion was reached that the measured potential was reasonably close to the actual potential of the powder.

The potential existing on an undisturbed tray of E. C. smokeless powder was determined under a variety of conditions. The moisture content of the powder was reduced to as low as 0.7 percent. The air velocity was altered from zero to 11 feet per second in a 5-inch line. The relative humidity of the incoming air was varied from 25 percent at 3°C to 100 percent at 20°C. These observations were made intermittently both during the summer and winter months and at no time was a potential greater than 50 volts recorded. In general, higher potentials were associated with dry powder, regardless of conditions of the incoming air.

HIGHER potentials were obtained by agitating the E. C. powder. A fresh sample of powder was placed in a tray and dried by passing air continuously for 2½ hours. The temperature of the powder was maintained at 65°C. while the outside relative humidity was 25 percent at 3°C. At the end of the run the moisture content was 0.22 percent. On raking, a potential of 250 volts was obtained, which dropped to 150 volts in one minute after raking was stopped. One hour later, on continued drying, this charge had disappeared, but on again raking a charge of 200 volts developed. Three more determinations were made at one-half hour intervals. Similar results were obtained with each of these determinations.

Steam was then run into the drying air for the purpose of finding the effect of humidity on the charge developed on the powder. After running one hour, during which time the incoming air had a relative humidity of 71 percent at 10°C. and the powder was at a temperature of 65°C, there was obtained on the undisturbed powder a potential of 100 volts. The moisture content of the powder on the top of the tray at the end of the run was 0.25 percent. The powder potential acquired by raking dropped continuously, but there was no sudden alteration in potential upon increasing the humidity of the incoming air.

The effect of moisture content of E. C. powder upon the potential developed by raking is best seen from graph

*Hercules Experiment Station, Hercules Powder Company, Kenvil, N. J.

shown in Fig. 1, where the potentials obtained during various runs are plotted against the moisture content of the powder taken at the time the potential was measured without regard to temperature, air velocity or other variables.

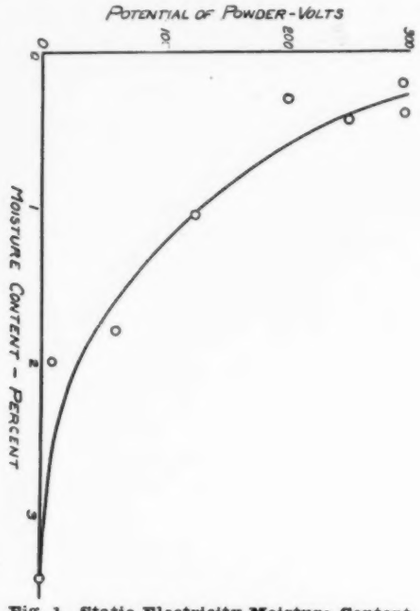


Fig. 1. Static Electricity-Moisture Content Curve for E. C. Powder.

The effect of the type of rake used was studied. Under otherwise identical conditions the powder was stirred with a wooden rake, iron rake, and finally with the hands. The following potentials were recorded: Wooden rake, 310 volts; iron rake, 280 volts; stirring with hands, 300 volts.

Apparently there is little or no difference to be found in using various rakes. The operator stood on a sulphur-insulated platform and agitated the powder with a steel rake. His potential soon rose to a permanent value, which was measured by means of the electroscope and found to be about 200 volts. At the same time the potential of the powder was found to be 45 volts. However, if the operator stood on the ground, instead of the insulated platform, and raked, a value of about 300 volts on the powder was obtained.

During these experiments, unsuccessful efforts were made to draw a spark from the operator and rake by touching them with a grounded copper wire.

THE above tests on E. C. powder were repeated with a gelatinized nitrocellulose powder, hereafter referred to as "Pryo" powder. The powder was heated quickly to 50°C. and raked vigorously. A potential of more than 3,200 volts, the maximum reading on the electroscope, was recorded. The powder was then cooled to 15°C. by passing cold air through it for about five minutes. At the end of this time it still possessed a charge of 2,200 volts. Twenty minutes later a potential of 900 volts was recorded. The incoming drying air was then turned off. At the end of five minutes a potential of 780 volts was noted. The drying air was turned on and after five minutes a potential of 760 volts was found. The powder was again raked until its potential rose to 2,300 volts. Then after the powder stood one hour, without air being passed through, a potential of 2,300 volts was recorded. The "total volatiles" of the powder at this time was 0.96 percent.

"Infallible" smokeless powder containing 40 percent N. G. was next tested. After heating for one hour at 50°C with air having a relative humidity of 40 percent at 1°C., no static could be detected by raking. The high conductivity of this powder precluded the possibility of static electricity.

The ability of a static charge to ignite powder probably depends more upon the heating along the path of discharge than upon any other effect. Since the heat energy in a spark is proportional to the capacity of the system from which the discharge took place, the capacity of the drying tray and other objects likely to store a charge was measured.

The capacity of the system entering into a discharge is not easily obtained. An examination of one dryhouse revealed no insulated object, other than the tray itself, which was capable of storing a charge. The powder is an insulator when dry and is not capable of conducting a charge from more than a few grains to a particular point for a discharge. The capacity of the powder was nevertheless obtained as a method of estimating the danger. This capacity itself is not easily approximated. The powder rests upon a cloth and grounded wire screen. Through this the charge on the powder was eventually removed. If static had been generated continuously and uniformly at all parts of the powder, due to the passage of air through it, at equilibrium both the highest potential and the greatest amount of static would have existed at the top of the powder. In this case the total charge would have been at the upper surface of the tray and could have been measured by bringing a conductor rapidly down to the surface of the powder. On the other hand, if the powder had been raked, the charges would have remained practically fixed in the powder for several minutes due to the high resistivity, about 10^{14} ohms, of the powder. During this interval there would have been a somewhat uniform charge distribution, and lines of force from the charged particles would have extended in all directions, but principally down to the grounded screen bottom of the tray. However, on lowering a grounded screen on to the top of the powder, the field would have been the same for both the upper and lower screen, and a charge would have been induced on the upper screen equal to one-half that of the powder.

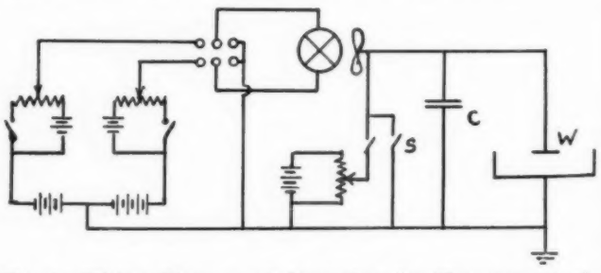


Fig. 2. Wiring Diagram of Apparatus for Measurement of Potential.

The charge on the powder was measured with an apparatus of which the schematic diagram is given in Fig. 2. A screen, W, was lowered down on the powder while the switch, S, was open. In lowering the screen an electrical charge was induced upon the screen and an equal quantity of electricity therefore appeared on the condenser, C, of one

mfd. capacity. The small potential that appeared between the plates of the condenser was measured by means of a Lindemann electrometer, as shown in the figure. Knowing the capacity and potential of the condenser, the quantity of electricity on the condenser and therefore on the screen could be calculated from the relation, $Q = CV$. The potential difference across the condenser never amounted to more than one or two volts so that the screen was practically at zero potential.

Knowing the total charge on the tray, and the potential of the powder, the capacity was taken to be $\frac{Q}{V}$. This assumed that all the electric charges were at the same potential, V, and that the energy of the system was ½ QV.

The above considerations implied that the screen lowered on the powder covered the whole tray; but it was sufficiently accurate for the purpose to use a 6 x 6-inch screen and multiply the charge thus obtained by the ratio of the area of the tray to that of the screen.

The quantity of electricity under the screen, measured as above described, was found to be 0.017 microcoulombs when the potential of the powder was 200 volts. The capacity of the powder under the screen was therefore about 0.00009 mfds., and for the whole tray was .002 to .003 mfds. The experiment was repeated with Pyro powder and about the same capacity obtained.

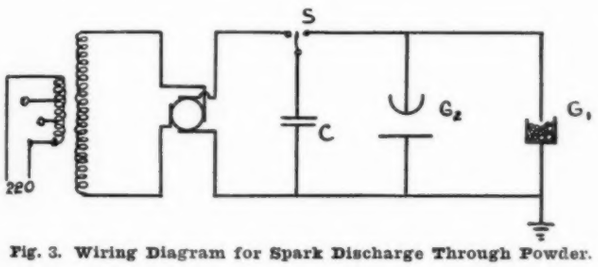


Fig. 3. Wiring Diagram for Spark Discharge Through Powder.

The power of sparks of known magnitude to ignite E. C. powder was tested by means of an apparatus shown diagrammatically in Fig. 3. The condenser C was charged by means of a synchronous rectifier and high tension transformer. After charging, the switch S was turned and the condenser allowed to discharge through gap G_1. The space between the electrodes of this gap contained the powder to be tested. The potential of the average discharge was measured by means of the sphere gap G_2.

The material used in these tests was a quantity of dusty E. C. powder, a photograph of which is seen in Fig. 4. The powder was at a temperature of 80°C. during the tests. Since it was not safe to confine the powder the moisture content changed somewhat during the heating of the powder up to the required temperature. The time of heating often amounted to twenty minutes, and the higher values of moisture content noted in the data are unreliable for this reason.

THE character of a spark depends largely upon the resistance, inductance and capacitance of the circuit forming the discharge. It has been stated that an increase in the ohmic resistance of a circuit increases the ability of a spark to ignite inflammable vapors. Smokeless powder is a poor conductor when dry and unless it contains moisture in excess of approximately 5 percent a spark discharge will pass

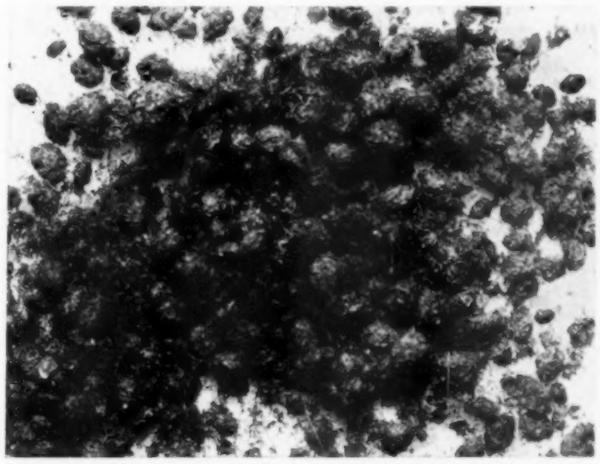


Fig. 4. Dusty E. C. Powder upon which Tests Described were Performed.

around the individual grains rather than through them. Hence it is not probable that the circuit would ordinarily contain appreciable resistance other than the resistance of the spark gap. In view of this uncertainty it was decided that a circuit with no appreciable resistance other than the spark gap would best represent actual conditions. The inductance of the hypothetical discharge would probably be low and for this reason the laboratory circuit was made so that it included an area of not more than 500 sq.cm.

The data obtained are given below. Each test corresponds to a fresh sample which was subjected to sparks at the rate of one per second until the number of applications recorded in the last column was obtained. The capacity and potential difference of the condenser furnishing the discharge are given in the third and fourth columns below.

Table No. 1

Sample No.	Moisture Content %	Voltage in Kilovolts	Capacity, Mfds.	No. of applications without ignition
1	0.6	20	.002	100
2	0.6	17	"	100
3	0.6	22	"	100
4	0.6	22	"	100
5	0.6	22	"	50
6	0.6	22	"	100
7	0.6	22	.004	50
8	0.6	15	"	100
9	0.6	20	"	100
10	0.6	20	"	50
11	0.6	22	.0065	Ignited on 24th
12	0.6	22	"	55
13	0.6	28	"	22
14	0.6	28	"	Ignited on 15th
15	0.6	28	"	" " 9th
16	0.6	17	"	" " 9th
17	0.6	20	"	" " 3rd
21	0.6	20	"	50
22	0.6	20	"	50
23	0.6	20	"	100
24	0.6	25	"	18
25	0.6	22	"	Ignited on 6th
18	0.6	32	"	" " 15th
19	0.6	32	"	65
20	0.6	32	"	30
26	0.6	35	"	Ignited on 30
27	0.3	20	.004	" " 100
28	0.3	20	"	" " 3
29	0.3	24	"	" " 11
51	0.3	8	"	" " 4
52	0.3	8	"	" " 4
56	0.3	8	"	" " 15
30	0.3	20	.002	100
31	0.3	20	"	Ignited on 94
32	0.3	20	"	100
33	0.3	20	"	100
34	0.3	20	"	100
35	0.3	20	"	100

Table No. 1 — Concluded

Sample No.	Moisture Content %	Voltage in Kilovolts	Capacity, Mfds.	No. of applications without ignition
53	0.3	8	.002	100
54	0.3	8	"	100
55	0.3	8	"	100
35	0.3	25	.001	100
36	0.3	25	"	100
37	0.3	25	"	100
38	0.3	25	"	100
39	0.3	25	"	100
40	0.3	25	"	100
41	0.3	25	"	100
42	2	24	.004	Ignited on 38
43	2	25	"	" " 20
44	2	24	"	" " 15
48	2	29	"	100
49	2	29	"	Ignited on 18
50	2	29	"	" " 18
45	2	24	.002	100
46	2	24	"	100
47	2	24	"	100

THE data plotted in Fig. 1 show that a moisture content below 1 percent is necessary for the development of an appreciable amount of static on E. C. powder. This was the only variable found to have any effect. All others, such as velocity, humidity and temperature of the incoming air were of negligible importance.

In determining the amount of static necessary to ignite E. C. powder, the voltage of the spark appeared to have little effect upon the ignition of the powder. In two cases, at .002 mfds. and at .004 mfds., the voltage was reduced 300 percent without producing any noticeable change in the ability of the spark to ignite powder. On the other hand, a decrease of 100 percent in the capacity of the condenser plainly altered the discharge from an igniting to a nonigniting spark.

The energy stored in a charged condenser is $\frac{1}{2}$ CV^2, where C is the capacity and V is the voltage of the condenser. On discharge the part of this not lost in radiation appears along the path of the spark as heat. However, the igniting ability of the spark probably depends upon the heat emitted per unit length of spark, that is, in $\frac{CV^2}{2d}$, or $\frac{1}{2}$ CG^2d on substituting Gd for V, where G is the breakdown gradient of air and d is the length of the gap. According to this view the igniting power of the spark is directly proportional to the voltage, but this is still not in accord with the observed facts.

The capacity of the condenser of the circuit necessary to ignite the driest powder obtainable was about 0.002 mfds. With a capacity of 0.001 mfds., no ignition was observed with dry powder. These values are to be compared with the measured capacity of about 0.002 mfds for E. C. smokeless powder. It is, however, inconceivable that one-hundredth of the charge on the powder could ever enter into a single discharge by conduction through dry powder.

One other possible capacitance in the dryhouse is the operator. However, the capacity of a man is less than a sphere having his height as diameter. A sphere having a capacity of .001 mfds. would have a diameter of 80 feet.

A COMPARISON has been made between a number of physical quantities actually found in the powder and those that would not ignite the powder. These are briefly summarized in Table 2. Contrary to the above discussion, the capacity of the powder supplying the spark for the imaginary discharge was considered to be 0.002 mfds.

The first three columns give the calculated values from the data provided in Table 1, the numbers at the head of each column referring to the sample numbers of that table. The rows are self-explanatory.

Table 2

	Static Found on Powder		Sparks unable to ignite E. C. Powder		
	E. C. Powder	Pyro Powder	Exp. 7-10	Exp. 53-55	Exp. 35-41
Capacity—mfds.	.002	.002	.004	.002	.001
Potential—volts	300	3200	20000	8000	25000
Heat value—calories	.00002	.003	.2	.015	.07
Quantity of electricity—microcoulombs	0.6	6.4	80	16	25
Heat intensity—calories per cm	.002	.03	.3	.06	.09

The quantities here listed must measure to a large extent the igniting power of the spark. It is seen that the static actually found in E. C. powder is less than one-tenth that found insufficient to ignite E. C. powder.

Without exception the figures reported above are for powders of moisture content below 0.6 percent. The danger of ignition drops off rapidly with increasing moisture content until at values of about 2 percent—the moisture usually met with in the dryhouse—the possibility of static has disappeared.

TO summarize, as a means of estimating the danger of the presence of static electricity in a smokeless powder dryhouse the amount of static appearing on an undisturbed tray of powder was measured under a variety of conditions of humidity, velocity and temperature of the incoming air.

Larger quantities of static appeared if the powder was raked; but the amount, provided the rake was not well insulated, was found to depend principally upon the moisture content and was independent of velocity, humidity and temperature of the incoming air.

The amount of powder appearing on pyro powder when agitated was much larger than that appearing on E. C. powder under the same conditions.

The ability of sparks to ignite E. C. powder was measured by discharging a condenser of known capacity charged to a known potential through hot powder of varying moisture content.

From the data it was concluded that a negligible amount of static electricity exists on smokeless powder as it is dried by the passage of heated air through it.

A moisture content of less than 1 percent is necessary for the existence of a measurable quantity of static on the powder.

E. C. powder must be violently agitated to obtain an appreciable charge on it.

The maximum amount of static electricity on E. C. powder, when measured in terms of its capacity and potential, is of a lower order of magnitude than the amount capable of igniting E. C. powder.

There is no danger of static electricity igniting the powder in an E. C. dryhouse.

AUTHOR'S NOTE: The writer is indebted to Capt. F. F. Reed, with whom he coöperated during the early part of the investigation, for valuable assistance and advice given.

The Macroexamination of Steel

Metallographic Methods Used at the Watertown Arsenal

By M. G. Yatsevitch*

THE importance of metallographic methods for macroexamination of steel in their application to inspection, control of manufacture of various steel products and to research work pertaining to steel, was felt by the Watertown Arsenal for over twenty-five years, and some methods were used freely. Systematic use of the methods on a large scale has developed, however, only within the last few years, and has caused critical study of methods used formerly and the introduction of certain definite developments in them, which seem to have some general interest not only for ordnance work but for the steel industry at large.

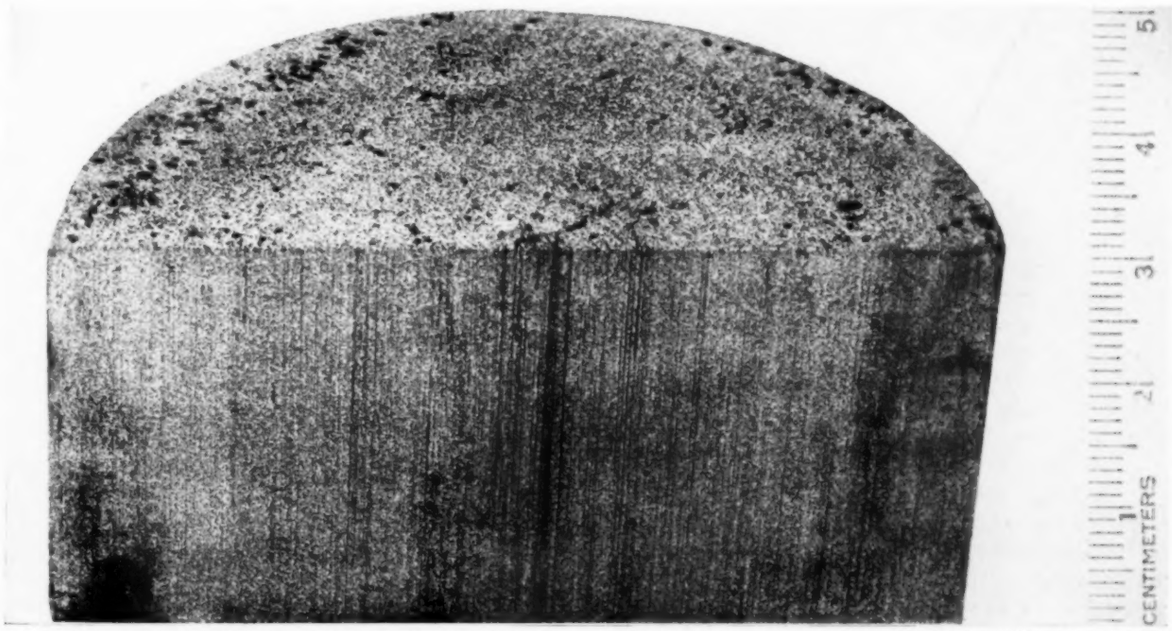


Fig. 1. Low carbon Steel Bar, Rolled, Sectionalized to Show Longitudinal and Transverse Sections, After Macroetching.

Correlation between the macroetching pattern of transverse section and longitudinal stripes is plainly seen. The dark spots represent areas occupied before macroetching by nonmetallic inclusions (manganese sulphide, phosphides, silicates soluble in acids, etc.), which, as seen from longitudinal section, were elongated and stretched out in one direction by rolling. Macroetched 15 min.

Metallographic *macroexamination* has as its purpose the determination of important characteristics, regularities and irregularities of the structure of the metal, which may throw light on its quality; contrary to *microexamination*, which presupposes the use of high magnifying power of the microscope, macroexamination is usually limited to characteristics visible to the naked eye or, in extreme cases, under small magnifications. Ordinary magnifying glasses are often used for macroexamination. Particularly suitable, however, are binocular microscopes, developed lately.

In order that the structure of the metal may be plainly discernible, macroexamination has to deal either with the fractures at important points of the piece of metal, or with its surfaces on which the structure is otherwise revealed.

The study of fractures and their correlation with the properties of the metal is extremely interesting, and to an experienced observer can give important information not only regarding the quality of the metal, but also about defects in the method of manufacture. Unfortunately the judgment of fractures is a difficult matter, very few people have sufficient experience to do that, very little systematic study has been made in that respect, and, besides, fractures of comparatively large pieces of metal are difficult and even impossible to obtain. Thus other methods of revealing the structure, or, better to say in this case, the "macro-structure," of the metal are of extreme importance.

All these methods are founded on the general fact, that different structural components, composing the aggregate, called by us "steel," which is from a chemical point of view a typical "mixture" of different "substances,"[1] are variously affected by certain chemical reagents. Thus: hydrochloric or sulphuric acids will attack rapidly the manganese sulphide always present in steel, leaving voids in the places occupied by it and evolving hydrogen sulphide as gas; copper chloride solution, if placed in contact with a clean, polished steel surface, will precipitate metallic copper preferably on places occupied by iron, i. e. a component of

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1. Like granite or any other rock, which are "mixtures" of different minerals. The minerals in this case are "components" of "mixture"-rock. See A. Smith "Introduction to Inorganic Chemistry," 1925, pp. 1-27.

steel, ferrite; if acids or other reagents will exercise a chemical action on crystals of ferrite, the progress of the action will not be uniform on different faces of the crystals or grains. The above examples are adequate to show, that in the result of sufficiently long chemical action of some particular reagents on a suitably prepared surface of steel, there will be obtained on that surface a pattern indicating the distribution and shape of different components. Such a method of revealing the pattern showing the macrostructure of the metal is called *macroetching*.

However, partly the same pattern may be produced not on the metal itself but on ordinary photographic silver bromide paper, without apparent injury to the surface of the metal. This is done simply by carefully placing the paper, preliminarily soaked in a solution of sulphuric acid, with its emulsion side on the surface of the metal and after a while taking it off. The paper will then have a brownish and a yellow pattern, produced by the formation of brown silver sulphide and light yellow silver phosphide in places of contact of the emulsion of the paper with the zones occupied on the surface of the metal by sulphides (of manganese, iron) and phosphides present in the steel. This method is essentially the same as macroetching, but the action of sulphuric acid absorbed by the emulsion is carried only far enough to affect the sulphides and phosphides, and produce the picture of their distribution by fixing the pattern on the emulsion of the paper. Such pictures, obtained on photographic paper, are usually called "sulphur prints" (and the method—"sulphur printing"), this terminology is quite incorrect and very often leads to serious misunderstandings, as the pictures show not only distribution of sulphur in the steel, but also of phosphorous. The proper name for the pictures is Baumann prints, as Baumann (in 1906) was the first to discover this simple and serviceable method of metallographic examination of steel and iron. It is quite possible to develop a method like "Baumann printing" for revealing the distribution of sulphur alone without phosphorous; in fact, for instance, H. J. Van Royen and E. Ammermann[2] use with apparent success for this purpose paper in which silver bromide is replaced by mercuric chloride (sublimate), but their method has not yet received general recognition.

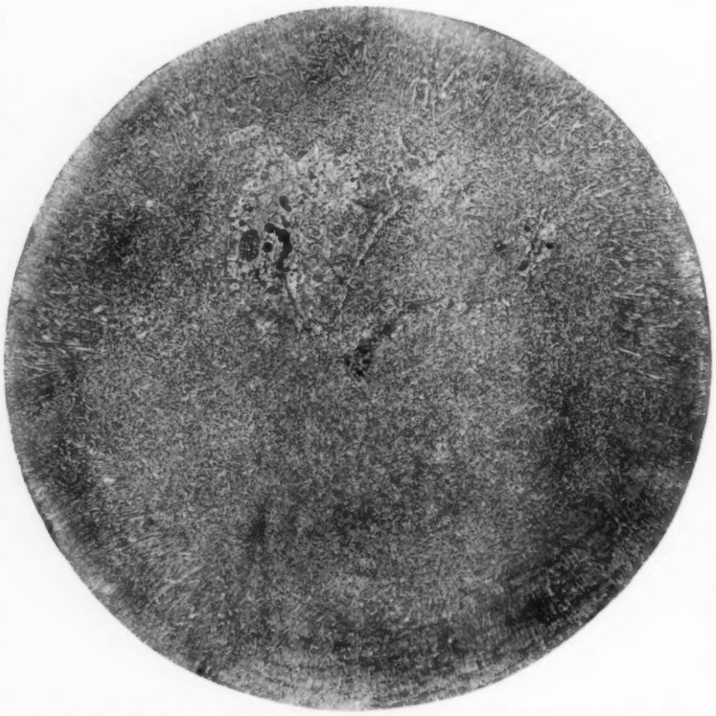


Fig. 2. Round Ingot 16-inch Diameter as Used in the Manufacture of Seamless Tubes.

Composition: C. 0.45, Mn. 0.64, Si. 0.225, S. 0.022, P. 0.018; a typical change in the zones of various crystallization from outside to center. Remnants of pipe and metallic and nonmetallic segregations are well shown. Such segregations are not desirable.

Macroetching supplemented by Baumann prints constitutes at present one of essential and principal parts of *macroscopic* investigation of steel. They help to establish macrostructure and irregularities in the metal, they show for an experienced observer the character of previous working of the metal and open many defects: external or internal, otherwise hidden from the eye. Macroetching method can be and is usually applied to large pieces and cross sections of the metal, which gives this method considerable advantage over microscopic investigation, where conclusions regarding the metal have to be made from a structure observed on a small area. However, both methods: macroexamination (macroetching with Baumann prints) and microexamination, do not exclude each other at all, but only complement, as irregularities revealed on macroexamination and not sufficiently understood, have to be studied under the microscope.

If a macroetching reagent is supposed to be used as an all-round reagent, well suited to general conditions of industrial work, it has to satisfy the following demands:

1. The reagent must give good all-round results and be applicable to the majority of cases in usual conditions of ordnance and industrial work, revealing the greatest possible variety of structural characteristics and irregularities.

2. The reagent must be simple in its composition, easily prepared and inexpensive.

3. The reagent must not change its composition on standing, if kept in readiness in stock, and must be as stable as possible under the conditions of use.

4. The application of the reagent and all the operations connected with its use must be simple and easy to perform without much previous experience.

5. The reagent and conditions of its use must not be injurious or unpleasant for persons executing the work.

SPECIAL investigations and long experiments conducted at the Watertown Arsenal lately have proved that out of a very great variety of macroetching reagents offered and used at different times the most suitable and practical, from the point of view of the above demands, belong to a group of so called acid reagents. The best results were obtained

2. "Verfahren zum Nachweis von Schwefel in Stahl Schliefen"—Stahl und Eisen, 47, (1927), pp. 631-632.

with a special reagent developed during the investigation. It is a mixed solution of hydrochloric and sulphuric acids and is described in detail below.

It is interesting to note that the idea of using acids or acid reagents to reveal the macrostructure of iron and steel apparently dates back to the times of the alchemists. Réamur (1683-1757), who can be called the father of metallography, had already quite definitely used acids to establish the macrostructure of iron and steel and its relation to previous heat treatments, and in his works gives sketches of macroetched pieces of the metal, discusses macrostructure and gives directions how to distinguish by macroetching various grades of the metal. Rinmann, before 1774, published in Sweden a very interesting book "On the etching of iron and steel," which in 1774 was translated and published in Germany. Discussing macroetching with acid reagents he states: "etching gives an easy means of distinguishing various kinds of iron and steel as far as their hardness, density and similar or dissimilar inner properties are concerned." Thus the present revival of interest in acid reagents is quite logical and natural and has a definite history behind it. It is rather astonishing that modern metallurgists have left macroetching methods for so long without due attention to practical application and method.

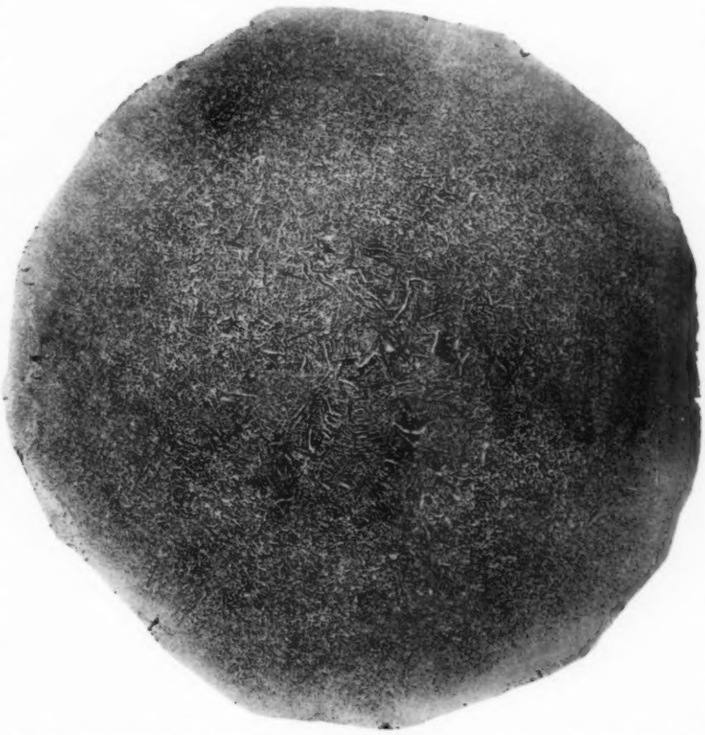


Fig. 3. Natural size, forging. Nickel-chromium Steel, WD3450 (C-0.50, Ni-3.00, Cr-0.80 approx.). Macroetched for 45 minutes.

A piece with shallow penetration of forging, which is satisfactory on the outside, but poor inside. Apparently there was a rush during forging ("war stock"); improper heating is responsible for internal cracks. Outside defects are unimportant, as they are not deep and will be taken off in machining.

ACCORDING to present knowledge the principal factors affecting results of the action of acid macroetching reagents may be classified as follows: (1) Factors pertaining to the steel specimen itself; (2) factors, connected with the etching reagent, and (3) factors, representing conditions, under which the action of the reagent on the specimen is carried out.

Factors of the *first group* are: (a) The chemical composition of the steel; (b) its condition, affecting metallographic composition (such as cast or forged condition, character of previous heat treatment, previous cold- or hot-working of the metal, etc.); (c) the size and shape of the test piece and the condition of the surface to be macroetched.

Factors, connected with the etching reagent, itself depend on its nature and concentration.

Factors, representing the condition of the action of the reagent on the specimen are: (a) The duration of the action or "etching time"; (b) the temperature at which the action takes place; (c) the quantity of the reagent as related to the size of the test piece, and (d) conditions of action, not mentioned above, such as: stirring the reagent, rotation of the specimen in it, etc.

For correct comparative judgment of steels of different chemical compositions by the macroetching effect produced on them by acid reagents, it is evidently essential to make uniform the condition determining all other factors enumerated above.

It is known that, other conditions being equal, steel taken as cast responds to macroetching more easily than steel in the forged condition; cold-working and annealing facilitate macroetching also; finishing temperature of forging and subsequent mode of cooling show their effect in macroetching as well. This is sufficient to realize, that, unless it is desirable to apply macroetching methods to steels in the very condition in which they are submitted, it is essential for correct comparative judgment to bring them preliminarily to the same normalized state and condition.

THE size, shape and finish of the surface of the specimen selected for macroetching are of importance. Large, heavy pieces are difficult and dangerous to handle in acid solutions, too long and narrow pieces require unusual shape of containers and unnecessary excess of reagent. Usually thin discs or slabs are the most convenient for handling, if their dimensions do not exceed much over 10 x 10 x ¼ inches. It must be remembered that one extra saw-cut, judiciously made, often leads to better results of etching and considerable economy in time and materials.

It is self apparent that, in general, selection of method and directions for sectionalizing a piece of metal to be subjected to metallographic investigation must be made with proper consideration of the object of the test. This condition is often disregarded and the results of the tests, if not quite lost, do not yield full possible results.

With regard to the surface, on which the macroetching pattern has to be revealed, it is essential to have it of such good finish that, after sufficient action of the reagent, it will not show traces of tool marks, which interfere with regularities of the picture, produced by etching. Such marks can seriously mask some delicate but important details and make proper interpretation of the results impossible. On

the other hand in order to make the etching most useful for production work preparation of the surface has to take the possible minimum of time and labor. While for very drastic and very deep etching a surface with coarse finish can be satisfactory, for a delicate etching, where fine details are desirable and small variations in time of etching are considered as important, the finish of the surface must be accordingly sufficiently fine.

Special experiments proved definitely that for the usual methods of macroetching with reagents consisting of 50 parts (by volume) of hydrochloric acid and 50 parts of water or of 38 parts of hydrochloric acid, 12 parts of sulphuric acid and 50 parts of water, polished surfaces are not necessary; at the same time a surface produced by cutting with a hack-saw—even a very fine one—is not desirable, as often the cut marks appear on the etched surface distorting the pattern. Though in such cases a very experienced observer may avoid errors in judgment of the metal, it is to the interests of proper inspection to use better surface finish. This could be accomplished by filing the cut surface with a fine file and by finishing it with emery paper No. 0 or No. 00. Constant and extremely satisfactory results, however, were achieved by using surfaces prepared by grinding on surface-grinders with Norton grinding wheels of "38 Alundum" or "19 Alundum" brand of soft or medium grades and of 80 or 90 grain size: for instance a wheel of usual Norton designation "3880-J" gave always excellent results. It is of importance to insist on small feeds (within 1/500-1/1000-inch) during the grinding operation to avoid "burning" the metal, the effect of which, if deep enough, shows itself after etching by appearance on the surface of a series of dark parallel stripes, due to local structural transformation in the metal. The danger of burning is, however, very easily avoided without loss of time by a little more attention to the work. Altogether from a practical point of view *preparation of the surface* for macroetching *by surface grinding*, as indicated above, appears to be by far the most suitable method, which is easily carried out in any workshop or even in an up-to-date metallurgical laboratory, as small surface-grinders are a very useful and even necessary part of laboratory equipment, preventing loss of time and adding in a very appreciable degree to the perfection of metallographic work.

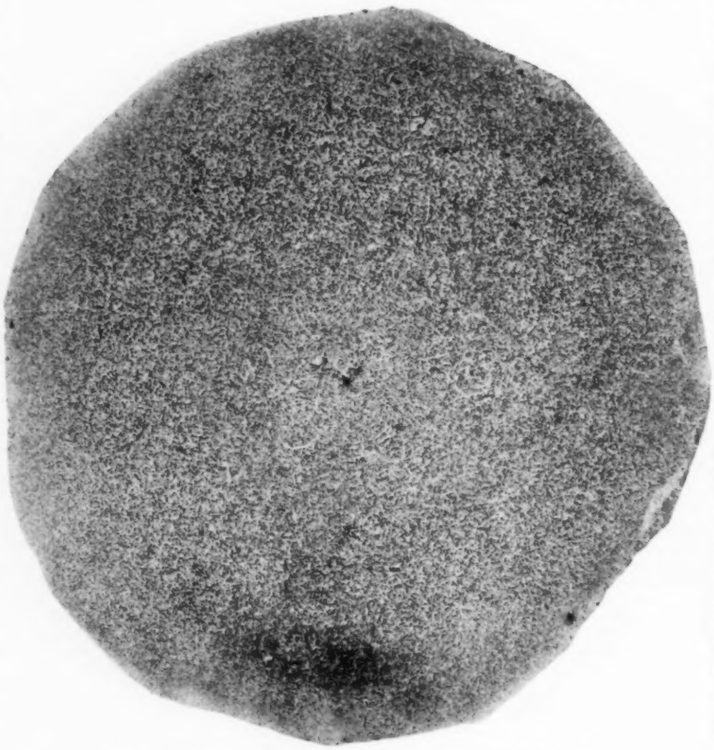


Fig. 4. Baumann print of Forging shown in Fig. 3.

It confirms the previous conclusion: good forging outside caused fine dissemination of sulphides and phosphides; nearer the middle dissemination is less uniform; larger grains and dendrites are not destroyed and sulphur and phosphorous compounds appear to be segregated in larger spots.

THE etching reagent recommended here consists of hydrochloric and sulphuric acids and water, taken in proportion 38-12-50 by volume, if the acids used are of so called in chemical trade *"reagent grade,"* i. e., they contain by weight correspondingly 36-37 per cent HCl (spec. gr. 1.19, 23° Bé.), 94 per cent H_2SO_4 (spec. gr. 1.84, 66° Bé.) and very little of impurities. However, *"technical grades"* of acids could be used with equal success, provided there is no misunderstanding with regard to the content of impurities, and the acids satisfy specifications for "technical grade acids" of reputable chemical trading firms. In the trade there are three principal "technical grades" of hydrochloric acid: 18° Baumé, sp. gr. about 1.42, containing by weight approximately 28 per cent HCl; 20° Baumé, sp. gr. about 1.16, containing by weight approximately 33 per cent HCl, and 22° Baumé, sp. gr. about 1.18, containing by weight approximately 35 per cent HCl.

Therefore, when using one of them, the volume composition of the reagent must be changed to approximately: 49-12-39 for hydrochloric acid 18° Bé.; 42-12-46 for hydrochloric acid 20° Bé.; 39-12-49 for hydrochloric acid 22° Bé. The quantity of sulphuric acid will remain unchanged, if ordinary "technical grade" of, so called, "66 acid" is used, as such acid contains 93.2 per cent H_2SO_4 (sp. gr. 1.83, 66° Bé.), which is close enough to the "reagent grade," mentioned above. Naturally, if acids of other concentrations are to be used, the volume composition of the reagent must be changed accordingly. It is preferable to have distilled water, although ordinary drinking water may generally be substituted in its place without causing any harm in the procedure.

The above composition of the reagent is selected in order that, under the average conditions of macroetching test, the boiling will not change concentration of acids beyond the limit favorable for the test.

The liquids are measured in the usual way in separate dishes and mixed together, first very gradually adding sulphuric acid to water in order to avoid heating of the solution, and, when the solution is cool, carefully adding it to the hydrochloric acid.

The total necessary quantity of the reagent depends on the surface of the specimen to be macroetched. The following table may help to avoid waste of the reagent used.

Table I. Practical Table for Determination of Quantity of Reagent, Required for Macroetching.

Approx. surface of the specimen in sq. inch.	1	2	3	4	5	6	7	8	9	10							
Volume of Reagent in ccm.	75	125	150	185	225	250	270	295	310	340							
Approx. surface of the specimen in sq. inch.	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Volume of Reagent in ccm.	440	540	610	680	750	820	880	950	1000	1090	1150	1200	1250	1300	1350	1400	1450
Approx. surface of the specimen in sq. inch.	100	110	120	130	140	150	160										
Volume of Reagent in ccm.	1500	1600	1650	1750	1850	1900	2000										

The shape of the dish, in which the etching is performed, or the shape of the piece itself, may be such, that a larger quantity of the reagent than given in the table is required to cover the piece completely with the liquid. In such cases excess of the reagent is necessary, as the entire piece must be well under the surface to prevent uneven etching. This is why careful selection of test pieces of proper dimensions is important.

It is not advisable to use the partly spent etching reagent over again if very good results are desired. The low cost of "technical grade" acids makes any possible economy in this respect insignificant.

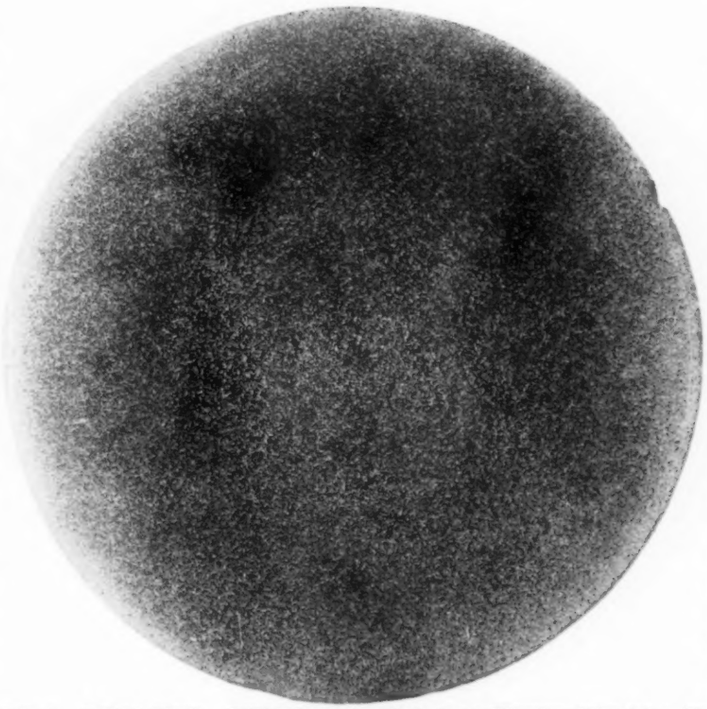


Fig. 5. Rolled Stock. WD1055 steel. Etched 20 Minutes (Started with Cold Solution).

Satisfactorily uniform and well worked metal. The dark voids nearer the center indicate small localizations of sulphur and phosphorus. Remnants of "columnar" grains are present along the surface.

ETCHING time, or duration of action of acid reagent on the specimen, is one of the most important factors of macroetching. In general, all other conditions being equal, the longer the etching time, the stronger the effect of macroetching: if the etching time is not sufficient, the picture obtained on the specimen may be incomplete, the structure of the piece with many important details not sufficiently outlined, and conclusions regarding the quality of the metal will be incorrect. On the other hand, if the etching time is too long, the appearance of the metal to an inexperienced observer may suggest much worse metal than it is in reality. As the action of etching reagent consist in the first place in "eating out," dissolving in acids, such constituents, which are more easily attacked by the reagent, their location will be marked by hollow spaces, cavities and holes. In the beginning of the process of etching such places usually show themselves as fine spots, but with time their dimensions grow far beyond the real size of such components actually present in the metal, as nonmetallic inclusions, sulphides, phosphides, etc., which constitute the undesirable parts of the metal. Sometimes it is possible that after a too prolonged etching the macroetched surface shows a better metal than does short etching. This is because the first sharp outlines of easily attacked regions, which always give an unpleasant impression of abrupt discontinuity, lose with time their definite appearance, the metal yielding not so quickly to the action of the acids, being attacked also, the sharp edges of its dendrites rounding off, and the general appearance of the surface becoming smoother and less ugly looking then in the first stages of macroetching. For this reason it is advisable to note the changes on the surface of the pieces at the beginning of the etching and bear them in mind when making final decision about the metal. The composition of steel influences greatly the time necessary to produce macroetching effect and it is evident that it is impossible for a given reagent to establish one standard etching time for all kinds of steels. The correct period has to be determined experimentally for steels of different compositions by separate etching tests; even then, taking into consideration always possible variations in heat treatment and other conditions, this etching time can be regarded only as certain approximate data, departures from which are necessary, depending on each given case and on the experience of the person conducting the macroetching. It is also evident that reagents not so vigorous in their action allow more latitude with regard to time and make it easier to attain proper results in etching.

It is remarkable that the reagent described above showed itself in this respect similar and even perhaps more favorably than the solution of hydrochloric acid (consisting of 50 parts of concentrated acid and 50 parts of water) ac-

cepted by the Committee on Macroetching of The American Society for Steel Treating as standard reagent.

In general, etching time as determined experimentally for different steels by the Committee on Macroetching of A. S. S. T. for their standard reagent can be applied, when using the reagent recommended here, but with regard to both reagents, it is important to remember, that this "time" is only an *approximate* "etching time" for normalized steels and that there always may be cases when it is necessary to prolong or shorten the etching time to develop certain special details. In Table 2 are given "etching times" for steels, particularly used in ordnance, and in Table 3 for the steels covered by the specification of the Society of Automotive Engineers including some other steels. Gun forgings of the composition usual at present require for their macroetching about 30 minutes, providing the specimen and the reagent are preliminarily preheated to about 95° C, or just about the boiling point of water; otherwise much longer time is required, particularly for large test pieces.

Fig. 6. Forging Intended for Breech Blocks; Nickel-chromium Steel, WD 3415.

Metal with not thorough forging, with work penetrating more in a vertical direction and not quite reaching the middle. Porosity abundant at the outside from the left will not spoil the metal, if there is sufficient stock to be discarded from the outside.

AS in all chemical reactions the temperature, at which macroetching takes place, affects the speed of action of acids, i. e., the loss of weight per unit of the surface of the metal, or the depth to which macroetching penetrates the surface of the specimen at a given time. Naturally, for steels of different composition, condition and heat treatment the influence of temperature will vary, but "etching time," properly selected for a given temperature, may cover this difference. Thus "etching temperature," i. e., the temperature of the reagent at which its action on the piece is allowed to take place, is as important as "etching time." Considerations of practical conditions in the technical laboratories and in the workshops (where sometimes the test has to be carried out) make it desirable to avoid troublesome, exact measuring of temperature and to select, as standard, the temperature of boiling of the reagent and to *keep it just at the simmering point during the work* to prevent excessive evaporation. In this way the control of the conditions of the bath will consist only in observation and regulation of the boiling. The reagent recommended above has such composition, that, when boiling under usual conditions of work, it does not change its action beyond satisfactory practical limits. Also its action is slow enough to permit such variations in "etching time" for different steels, as inevitably occur in practical circumstances.

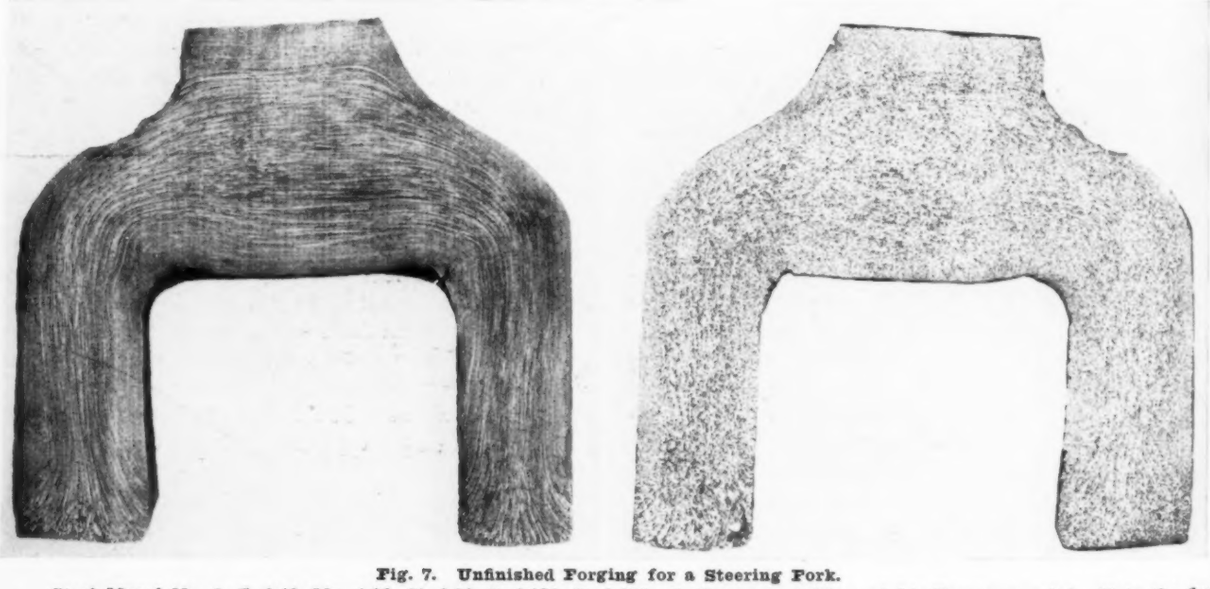
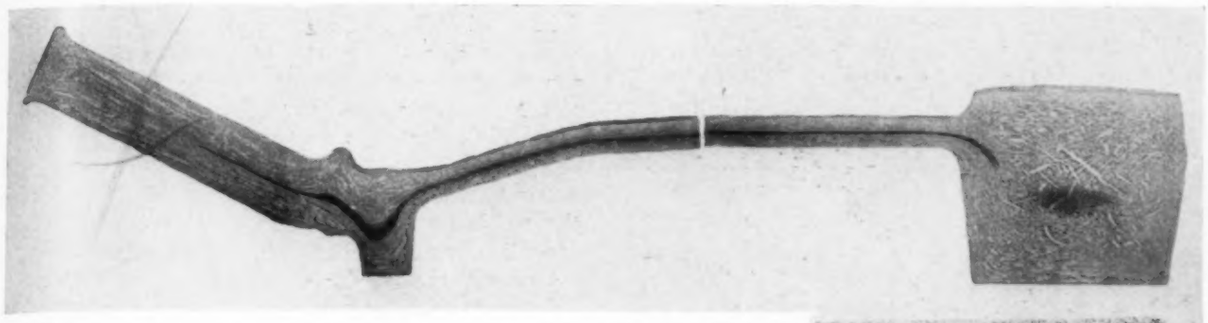


Fig. 7. Unfinished Forging for a Steering Fork.

Steel Maxel No. 2, C. 0.40, Mn. 1.06, Si. 0.23, S. 0.058, P. 0.058. Left: macroetching; right: Baumann print. Note the flow lines of the metal shown on both pictures, well outlined by interdendritic substance more soluble in acids.



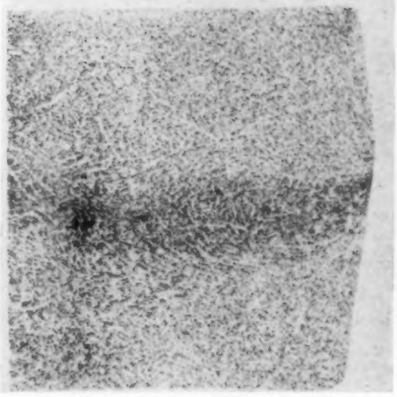


Fig. 8. Drop forging; Operating Handle of a Gun Carriage.

Nickel-Chromium Steel, WD3450.

Above: ½ natural size, macroetched. The dark line in the middle is due to the segregation of metal richer in sulphur and phosphorus. The handle end shows forging lines and plenty of mechanical work, which is not the case at the other end. Microscopic investigation proved that the segregation in the center is harmless. Below: A Baumann print, proving that the segregation is connected with the enrichment of the metal in sulphur and phosphorus. The steel is good.

AFTER the surface of the specimen has been properly prepared, cleaned and wiped with gasoline or some suitable solvent to remove any traces of oil (which may cause uneven etching), it is put into a suitable dish (glass, porcelain, stoneware, etc.) covered with clean water and heated in the water to etching temperature. When the piece acquires proper temperature, it is taken out, carefully placed into the etching dish similar to the above, but containing the proper quantity of the etching reagent already heated to its simmering temperature, and the time is noted. (A gas or electric hot plate serves excellently for heating.) After the selected "etching time" has elapsed the piece is taken from the solution, rinsed well under the tap with water and carefully rubbed all over with a soft brush to eliminate all dirt and slimy carbon deposit covering the surface. After repeated rinsing the etched face is carefully wiped with a clean linen or paper towel and the piece is well dried either in a stream of warm dry air from a special laboratory electric dryer, used often for metallographic work, or by putting it on a clean hot plate for a few minutes, avoiding unnecessary extreme heating and currents of gas or products of its combustion which may tarnish the piece. Sometimes, after washing the specimen with water, it is rinsed with alcohol to help to eliminate the last trace of water present on the piece in the cavities, in the small pores, and in the cracks which may contain traces of acid and thus cause tarnishing of the macroetched surface. Sometimes boiling the etched piece in distilled water before drying it is recommended also. All such measures are excellent but, after some practice, it is possible to achieve remarkably good results by good washing under the tap and careful drying on a hot plate. Such is the regular procedure at the laboratory of the Watertown Arsenal and, experience shows, that macroetched pieces finished in this way preserve their surface in good condition for many days and weeks without tarnishing. Very often the contrast of the picture may be improved by carefully rubbing the macroetched surface with a very fine crocus or emery cloth, but, the writer's experience is, that cleaning the macroetched surface with an ordinary soft rubber eraser, such as is used by draftsmen, tremendously improves it and brings out the finest details. The operation may be resorted to repeatedly when the macroetched specimen becomes covered with a thin oxidized film. Pieces left after macroetching for weeks and even a month in the laboratory, after cleaning in this way, looked quite fresh and full of details and gave excellent photographs. Casual, small dirty spots appearing on the surface also can easily be removed by erasing.

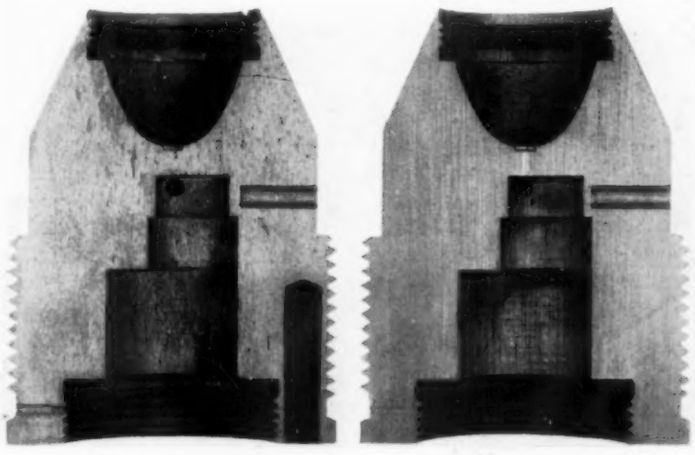


Fig. 9. Macroetched Fuzes, Made of Different Steels.

Right: rolled, uniform metal, well worked. Left: the metal is not uniform and is not so well worked, with many inclusions of considerable size, dendritic structure not so well broken as in specimen at right. The cracks on the inner surface of the top end are in reality places from which the inclusions were removed by etching.

It is often desirable to preserve macroetchings for long periods and many substances for covering the surface are recommended for that purpose. However, a freshly etched surface not covered with anything is best suited for judging the metal, and only delicate cleaning, as with the eraser just mentioned, may be helpful in this respect.

Often the large size of a piece to be macroetched makes impracticable and unpleasant the operation of trans-

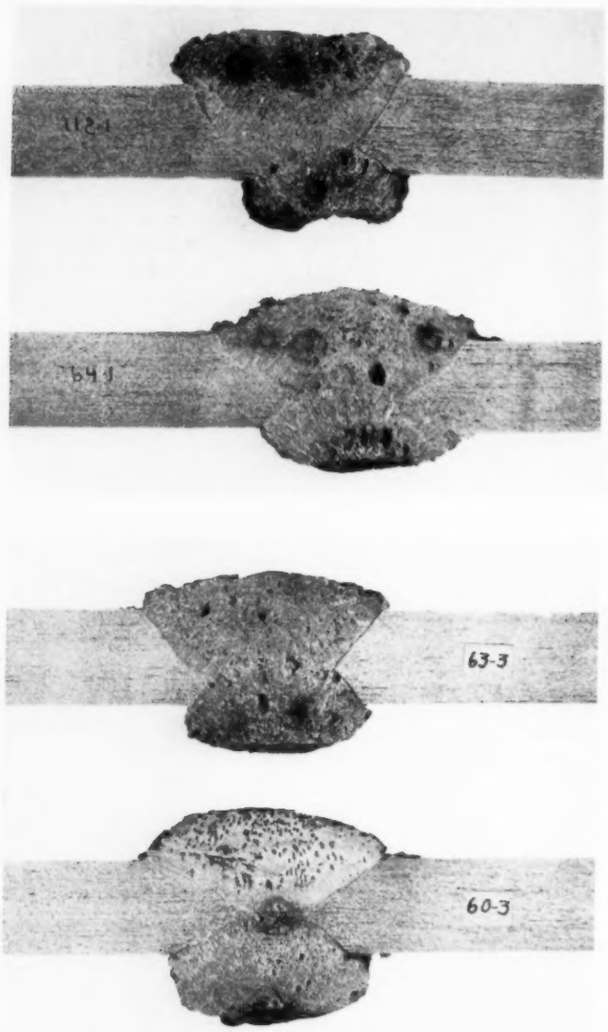


Fig. 10. Examples of macroetching of welds.
Plate-structural nickel steel, welding rods: 112-1-Ni-Cr steel rod, 64-1-Ni-steel rod, 63-3-Low carbonvanadium rod. 60-3-chromium vanadium rod.

ferring it for preliminary heating into a separate dish, and also of taking the piece out of hot acid for washing. In such cases, with a little practice, it is quite easy to obtain the same results by placing the piece in the dish, adding to it the reagent already heated, and pouring it off, either directly or by syphoning, after the usual "etching time," somewhat prolonged because of the low temperature of the piece during the first period of etching; the first washing can be done in the dish, and then finished with the cooled piece taken out. It is possible, of course, to heat the piece preliminarily in water, to pour the water off and then to add the heated reagent. Such a procedure diminishes the correction for etching time, but it is scarcely necessary as for usual conditions the difference in time from the previous method is not considerable. When using a cold reagent on cold specimens the "etching time" must be increased considerably, usually for the period necessary for heating the reagent to the temperature of etching. The size of the piece, because of great heat conductivity and small specific heat of the metal, is not of such importance in this respect as the quantity of the reagent used and this has to be considered in determining the time of etching. Usually in such cases the time established for etching of preheated specimens in preheated reagents may indicate the minimum period, after which the piece has to be examined to establish by its appearance the length of further etching. Again, experience and practice give here the best indications, which is of great importance, as this method of works: starting etching with a cold specimen and in a cold reagent, is often the only practicable one under working conditions. At the Watertown Arsenal it is used generally.

FOR taking Baumann prints the surface of the specimen is prepared by grinding in the same manner as for macroetching; slight rubbing of the surface with fine emery paper No. oo or No. ooo may help to produce more certain results. The dirt and the oil, which may remain on the surface after machining ought to be carefully removed by wiping and washing the piece with petrolic ether, ethylic ether or alcohol. A piece of bromide paper (Haloid, outline special, semi-matte, or any other paper of equal quality) is cut to the shape of the surface, but somewhat larger, and dipped into a 5 per cent solution of sulphuric acid where it is allowed to soak for about one minute. Usually by that time the emulsion will be sufficiently saturated with the acid and the paper is taken out by the edge and kept in a vertical position also for about one minute to let the excess acid run off. Then the paper is placed with its emulsion side on the prepared surface of the test piece, pressed lightly by hand and with a roller (as is usually done when photographs are put on ferrotype plates to give them a glossy surface) to expel all the air bubbles caught between the emulsion and the metal. After thus keeping the paper in contact with the specimen for about one minute, the paper is taken off, washed well, fixed in sodium thiosulphate (hypo) solution, washed again and dried in the usual way for photographic prints. The image formed on the paper in brown and yellowish tones is the Baumann print, which indicates exactly the position and shape of sulphides and phosphides present on the face of the metal and decomposed by the action of the acid. The operation does not require a dark room and can be performed in any shop as long as the paper, before fixing, does not become pink or brown from the action of strong direct light. The time necessary to prepare the specimen after its grinding and to obtain the picture for study does not exceed a few minutes, as it can be done while the print is being washed before fixing.

It is seldom possible to take two satisfactory Baumann prints from the same surface without regrinding it. The sulphides and phosphides usually appear decomposed to such an extent after the first contact with the acid of the emulsion that the second application of freshly soaked paper does not produce sufficient hydrogen sulphide and hydrogen phosphide to form a distinct image. However, taking a second print is advisable to check the first and to establish whether the white spots which may be present are not due to the bubbles of air overlooked and not removed during the first process. If darker spots appear on the second print in the places of the white spots of the first print the fact is proved, that the bubbles were present and the air prevented the action of the acid on the sulphides within the area of the bubbles. The reason for this conclusion is self-evident.

Table 2. Approximate "Etching Time" for Steels used in Ordnance design, as per Ordnance Department Document No. 2050 of November 18, 1924: "Notes on the Selection and use of metals in Ordnance design":

CARBON STEELS	
WD 1015	15 min.
" 1020	15 "
" 1025	30 "
" 1035	30 "
" 1045	45 "
" 1050	45 "
" 1055	45 "
" 1065	45 "
" 1075	45 "
" 1085	45 "
" 1095	45 "
" 1112	10 "
" 1120	10 "
" 1325	30 "
" 1350	30 "
NICKEL STEELS	
WD 2320	30 min.
" 2330	30 "
" 2340	30 "
NICKEL-CHROMIUM STEELS	
WD 3240	45 min.
" 3250	45 "
" 3415	45 "
" 3435	45 "
" 3450	45 "
MOLYBDENUM STEELS	
WD 4035	30 min.
CHROMIUM STEELS	
WD 5050	30 min.
" 50100	30 "
" 51235	45 "
" 52100	45 "
CHROMIUM-VANADIUM STEELS	
WD 6135	45 min.
" 6150	45 "
SILICO-MANGANESE STEELS	
WD 9250	30 min.
" 9260	30 "

NB. The "etching time" given above is approximate and is applicable in the case of macroetching reagent 38-12-50, (38 Vol. of hydrochloric acid and 12 Vol. of sulphuric acid and 50 Vol. of water) only when the specimen preheated to boiling temperature of water is placed into the reagent preheated to the same temperature; usually a longer time is necessary if a cold specimen is put into the reagent without preheating.

Table 3. Approximate "Etching Time" for Various Steels.

S. A. E. CARBON STEELS	
1010	15 min.
1015	15 "
1020	15 "
1025	30 "
1030	30 "
1035	30 "
1040	30 "
1045	45 "
1050	45 "
1095	45 "
1315	30 "
1350	30 "
1360	30 "
S. A. E. NICKEL-CHROMIUM STEELS	
3115	45 min.
3120	45 "
3125	45 "
3130	45 "
3135	45 "
3140	45 "
3215	45 "
3220	45 "
3230	45 "
3240	45 "
3245	45 "
3250	45 "
3312	60 "
3325	60 "
3335	60 "
3340	60 "
3415	45 "
3435	45 "
3450	45 "
S. A. E. TUNGSTEN STEELS	
71360	45 min.
71660	45 "
7260	45 "
S. A. E. NICKEL STEELS	
2315	30 min.
2320	30 "
2330	30 "
2335	30 "
2340	30 "
2345	30 "
2350	30 "
2512	30 "
S. A. E. MOLYBDENUM STEELS	
4130	45 min.
4140	45 "
4150	45 "
4615	45 "
S. A. E. CHROMIUM STEELS	
5120	30 min.
5140	30 "
5150	30 "
52100	45 "
S. A. E. CHROMIUM-VANADIUM STEELS	
6120	45 min.
6125	45 "
6130	45 "
6135	45 "
6140	45 "
6145	45 "
6150	45 "
6195	45 "
S. A. E. SILICO-MANGANESE STEELS	
9250	30 min.
9260	30 "
STAINLESS STEELS	
Stainless Irons	30 min.
Stainless Steels and 18-8 Stainless Steels	45 "
TOOL STEELS	
Carbon and Carbon-Vanadium	45 min.
Manganese Oil Hardening	30 "
Fast finishing	45 "
Tungsten hot die steel	45 "
Chromium hot-working die	45 "
High carbon, High Chromium	45 "
High Speed	45 "

Baumann prints can also be taken with good results from cast iron pieces. Here the metal surface and the procedure are the same as with steel but the concentration of acid must be lowered to 0.25 per cent and the exposure time to 15 or 30 seconds depending on the grade of cast iron.

For the examination of welds Baumann prints may be helpful in establishing the quality of welded material, "penetration" and position and defects of the weld itself. Often it is possible to obtain good Baumann prints from various steel objects during the process of their manufacture, without damaging them in any way, provided the surface has a sufficiently fine finish. Experiments with gun tubes and liners have proved that Baumann prints taken on the outside and in the bore may be helpful in establishing defects in metal and their causes.

THE interpretation of the picture revealed on the surface of the metal by good macroetching constitutes the most serious problem in the application of this method in practical use. In inspection work careless, superficial judgment often leads either to acceptance of unsatisfactory metal or to rejection of such pieces which could stand successfully the service assigned to them. The impossibility of having large masses of metal of absolutely irreproachable quality, and the necessity of considering in every case conditions of service and reasonable demands of designers is evident to every technical man with sound engineering education. From this it follows that the person interpreting macroetching results must understand properly in each particular case the value of the demands put on the metal by conditions of future service. If, for instance, the central part of a cylindrical forging is to be removed, there is no need to insist on the same homogeneity of the metal in that particular part as should exist in the outside part which has to stand service. On the other hand, very often apparently small defects, brought out by macroetching, signify much with regard to the manufacture of the metal, suggesting some gross irregularities. It is evident that a full appreciation of the real meaning of such defects can be expected only from a person having sufficient experience and knowledge in the chemical and mechanical technology of iron and steel.

In general, macroetching helps to reveal discontinuities in steel, in other words, its nonhomogeneity. The difference in the action of the reagent on various substances, the agglomeration of which composes the steel, produces the macroetching pattern, the uniformity of which is interrupted by various irregularities. The principal irregularities thus revealed can be enumerated as follows: seams, laps, cracks, pipes, blow and pin-holes, nonmetallic and metallic segregations, inclusions and dendritic pattern. The ideal steel, except when it is in the cast condition, when the presence of dendrites is characteristic, will show absolutely no irregularities after macroetching, the surface will appear uniform and only slightly and uniformly pitted from the removal of manganese sulphide and other impurities by the etching action of the acids. Such a picture is easiest for interpretation. Usually, however, the discontinuities named above appear and some of them have to be classed as defects and the others as inevitable irregularities in the structure.

In the interpretation of Baumann prints the same care has to be exercised as in the case of macroetchings. It is to be remembered that the print represents a mirror reflection of a macroetching picture, where sulphides and phosphides give a dotted brown-yellow outline of dendrides, metallic and nonmetallic segregations and other discontinuities. The more homogeneous the steel the more uniform is the distribution of the colored particles on the prints. The finer the grain and the better the working of the metal, the finer and more uniform is the dissemination of those particles. The best grades of steel give prints which seem to the naked eye to be uniformly colored. The uniformity rather than the intensity of color proves the quality of the steel.

ARMY ORDNANCE

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Month by Month

IT IS our pleasure again to announce the beginning of publication of a new series of front cover designs by the late Joseph Pennell. The first of the series, "The Old Gun Pit," appears with this issue. We are again indebted to Mrs. Elizabeth Robbins Pennell, widow of the artist, for her gracious permission to use these subjects.

Pennell Cover Designs

The War Work Series of Mr. Pennell's works, from which these drawings are selected, already constitute one of the truly great artistic presentations of the munitions effort of the World War. First in England and later in his native America, the artist contributed the genius of his brush and pen to the recording of scenes in the great ordnance centers. The power and fidelity of the Pennell subjects supplement in true likeness the other written documents of the time, and they present most vividly today the purposes for which this Journal stands. May they also, through this means, recall the brilliancy of an artist whose name is recorded among the great.

ONE of the finest indications of the leadership of Gen. Douglas MacArthur, Chief of Staff of the Army, and the degree of businesslike procedure to be expected during his régime was the recent announcement by the Secretary of War of the organization of an advisory body in the War Department to be known as the General Council. The order prescribing the formation of the new body recites that its purpose will be to review and properly coördinate, periodically, all major War Department projects and to determine current policy. The Council will be composed of the Deputy Chief of Staff, who will serve as its president; the Assistant Chiefs of Staff, and the executive officers of the offices of the Assistant Secretaries of War. The Adjutant General, the Chiefs of arms and other services, the Commandant of the Army War College and the Chief, Militia Bureau, will sit as members of the Council during the discussion of any important subject bearing upon their individual responsibilities. Under the order, they may elect to sit during the discussion of any important subject in which they are interested. No records will be kept except those necessary to record dates of meeting, officers present, questions considered and action taken.

General Staff Policies and The New Chief

The Council will report its recommendations to the Chief of Staff. When important matters of General Staff policy are brought before the War Council, the Chief of Staff will present the recommendations of the General Council thereon.

This new procedure assures closer coöperation and more uniform action on important questions. Due to the flexibility of its membership, the Council will be assured of the best evidence and advice direct from the most competent authorities in the War Department. Thus it will be fully qualified to give balanced consideration to important military subjects. It is intended to develop greater team work on the part of the Army as a whole.

This action of General MacArthur, following close upon the settlement of the ten-year-old dispute involving defense of the coast by the aviation services of Army and Navy, again calls to mind the brilliant record of the great soldier who is now Chief of Staff. A son of the late Lieut. Gen. Arthur MacArthur, the Chief of Staff was graduated from the Military Academy, class of 1903, and was commissioned a second lieutenant in the Corps of Engineers, thereafter engaging in various construction and engineering duties in the Philippines and in California. In 1908 he was graduated from the Engineer School of Application. Thence until 1917 General MacArthur served with Engineer troops at various stations and was assistant to the Engineer Officer of the Vera Cruz Expedition of 1914. During this period he served two tours of duty on the General Staff.

Soon after the entry of the United States into the World War General MacArthur became Chief of Staff of the 42nd Rainbow Division, in which position he served in France in various sectors and in the Champaigne-Marne and the Aisne-Marne defensive operations, being wounded at Neuviller in March, 1918. He commanded the 84th Infantry Brigade of the 42nd Division at St. Mihiel and in the Meuse-Argonne offensive, being again wounded at Exermont in October, 1918.

Following a tour of duty in the Philippines after the World War, he commanded successively the 4th Corps Area, Atlanta, Ga., the 3rd Corps Area, Baltimore, Md., and the Philippine Department. For his World War service he was awarded the Distinguished Service Cross with Oak Leaf Cluster and the Distinguished Service Medal.

This outstanding personal record and the above early official acts as head of the General Staff are an indication of the experience and ability of the new Chief of Staff. The formation of the War Department Council marks what we confidently believe will be, under his leadership, an era of marked progress for the Army as a whole.

THE *American Machinist* in a recent issue made the proposal that educational orders for munitions, a very vital element of munitions preparedness, might well be considered in the expenditure of emergency appropriations by the Congress for unemployment relief. Army Ordnance adds to the proposal of its contemporary its own approval of this sensible suggestion, which thus far has not received the serious consideration its importance deserves.

Educational Orders and Unemployment Relief

That educational orders for munitions are not considered seriously as a worth while media for the expenditure of emergency appropriations is not to be wondered at, although the logic of the proposal is quite beyond contradiction. Surely the utilization of the services and coincident education of many engineers and skilled laborers during the present depression on the production of small quantities of munitions offers an auxiliary solution to current economic problems. With these problems we are, of course, primarily concerned although the secondary objective would be the actual beginning of the educational orders idea.

So long as the Government is appropriating funds for unemployment relief and so long as there are industries to be endowed, why, it might be asked, should not the manufacturing establishment be allowed to utilize some of these funds for educational orders? Through this means the money would be spent not only for current relief but with the added educational value for the personnel concerned. If educational orders are not to share in relief appropriations it is difficult to see how they ever will be sanctioned. from current funds.

We have emphasized from time to time the necessity for educational orders. Their logic has seldom been disputed. That they are not designated as a part of employment relief is a decided step backward in the attainment of adequate industrial preparedness.

Reserve Officer Depletion

NOT so long ago the Assistant Secretary of War, Col. Frederick H. Payne, addressing a convention of the Department of Ohio, Reserve Officers' Association, warned that unless some means is found for checking the excessive losses among the junior officers in the Army Reserve Corps, a further depletion of approximately 10,000 reserve officers may be looked for by the end of 1931.

The Assistant Secretary said that one of the problems with which we must all be concerned is the continuous depletion in strength of the Reserve Corps. On June 30th last the number of reserve officers, not members of the National Guard, on the active status totaled about 80,000. He said that the attrition during 1931 would reduce this figure to less than 70,000 unless definite steps are taken to prevent excessive losses among junior officers.

The Assistant Secretary brings for discussion a very serious subject. Not only are the losses in graduates of the R. O. T. C. units exceptionally high, but the numbers of reserve officers who, through inactivity, are constantly being assigned to the inactive status or who are being dropped from the rolls altogether, are alarming. And yet these are the men upon whom the country depends for the necessary expansion of its officer component in time of war. If there is a more serious cause for concern about the progress of national defense we can not state it.

The day is fast approaching when men of World War experience are, through age, passing from active participation in reserve affairs. Unless the rising generation is imbued with the same spirit of devotion it is probable that Reserve Corps strength will continue to dwindle if left to its own course. To what extent attacks on military training in the schools bears upon this subject it is difficult to tell. It is a certainty, however, that unless very definite means are taken to stimulate and hold the interest of R. O. T. C. graduates in the responsibilities of the Reserve Corps we may again find ourselves destitute of trained officer personnel similar in degree to that which existed prior to the Plattsburgh Camps. The reserve component is an essential item in our three-part Army as it now exists. If this component shrinks to unproportionate totals, the fine balance required among the three can easily be disturbed and the efficiency of the whole irreparably damaged.

The Christie Tank

POSSIBLY in no other respect are the recent hearings before the War Department Subcommittee of the Appropriations Committee of the House of Representatives so enlightening as they are on the question of a light tank for the Army. It is too bad the hearings before this important Committee can not have wider circulation. There is evident on the part of a few officers who testified before the Committee a decidedly outspoken dissatisfaction with the light tank developed by the Ordnance Department. At the same time there is in the testimony a similarly outspoken approval of the vehicle developed by Mr. Walter Christie, one of which has been purchased by the Ordnance Department and will shortly be delivered by the designer for proving ground tests.

In his testimony before the House Committee, Maj. Gen. Samuel Hof, Chief of Ordnance, outlined the policy he has laid down for the Ordnance Department in judging the capabilities of the new Christie vehicle. At the request of General Hof a special board has been appointed consisting of representatives of the General Staff, Infantry, Cavalry and the Ordnance Department, to approve the type of tests to which the new vehicle will be submitted and to pass upon the results of the tests. It is quite evident from General Hof's attitude that the Christie tank, which has been the subject of much innuendo and unusually active sales promotion, is being viewed by the Ordnance Department with an open mind. Some officers seem to forget that the Ordnance Department has as its guiding principle the wishes and needs of the using services. At the same time the Department is charged with proper mechanical tests of the vehicles and weapons demanded and obviously intends to see that it gets them. We admire General Hof for the explicit stand he has taken on the subject and the lengths to which he has gone to assure a fair and open decision on the merits of Mr. Christie's vehicle.

An Ordnance History

THERE has recently come to our notice a three-volume History of the Army Ordnance Services, by Maj. Gen. A. Forbes, C. B., C. M. G., published under the auspices of the Royal Army Ordnance Corps of England. It is a most thorough and comprehensive work on the development of English ordnance from the time of the Norman conquest to date. The first volume might properly be classified as a treatment of ancient history on the subject; Volume 2 is devoted to modern history of the Army Ordnance Department covering the period from the Crimean to the World War, while the third volume treats of the

activities and services of the Royal Army Ordnance Corps during the World War.

Aside from the general fascination which a history of this kind has for so many of us, there is a particular reason for mentioning the subject in this place. It must be obvious to every student of munitions in this country that there exists nowhere a comprehensive historical work prepared and presented on such a scale. True, the World War produced many books of unimpeachable value which bear either wholly or in part upon the ordnance problem. These in certain respects may be regarded as histories of American ordnance for certain periods. Then there are the textbooks on ordnance and gunnery which, excellent though they are for the purposes intended, they do not serve as, and of course are not intended to be, histories in any sense of the term. The only one source of printed data on this subject is the collection of annual reports of the Chiefs of Ordnance which treat the various subjects in detail. However, there is much in them which has no general signification and their present uncodified form makes reference to them more a hindrance than a help.

Friends of ordnance in England have sponsored a very worth while undertaking which we in America would do well to follow. Let us hope that students of ordnance and even those who have only the casual interest in the fascinating history of munitions, may some day soon have at their disposal a history of American munitions comparable to that of English ordnance by General Forbes. It will fill a long felt need.

A Uniform Pistol Law

DURING the past year the conference of Commissioners on Uniform State Laws has had before it a proposal for the adoption of a uniform act governing the control of the use of firearms. The organization is composed of official representatives from each of the states, territories, District of Columbia, Porto Rico and the Philippine Islands. Since its organization in 1892 it has been engaged in promoting uniformity in state laws on all subjects where uniformity is desirable and practicable.

The proposed uniform legislation is confined to the pistol which is defined as "any firearm with a barrel less than twelve inches in length." The committee which drafted the legislation feels that further regulatory measures should be considered concerning machine guns and other offensive weapons, and recommends that a separate act be drafted to cover such weapons. The salient features of the proposed firearms act are: "(1) That provisions have been made to prevent any person known to be a criminal, or a narcotic addict, or an habitual drunkard, or a mental defective, from possessing a pistol; (2) that no one can be permitted to carry a pistol concealed without being duly licensed; (3) that no one can sell a pistol without being duly licensed, and the persons so licensed are in turn forbidden to sell to those known to be of the criminal class, narcotic addicts, habitual drunkards, and mental defectives, and they must know the identity of the person to whom the sale is made; and (4) that the possession of a pistol by a person not being duly licensed to carry it, at the time of the commission of a crime of violence, is prima facie evidence of his intention to commit the crime. The committee also recommends that this act provide for a fee to be charged for issuing license to carry firearms and for permit to sell. Such regulations are indicated in the act to accomplish these purposes."

As the committee which drafted the legislation commented, the proposed uniform act embodies some forms of regulation which have stood the test of experience in this country and that it embodies such new ideas as have been presented from time to time, notably by the Crime Commission and other organizations working along this line. Thus at the same time that it preserves the traditional methods of firearms regulation, it takes advantage of enlightened experience of recent years.

The control of firearms alone has been a moot question on which there are sincerely divergent views. These have taken form ranging from sensible control measures, such as that recommended to the commission, to absurd confiscatory mandates aimed even at the elimination of firearms manufacture. The suggestion often has been advanced that the carrying of weapons should not be restricted at all and that the possession of a gun upon the person of one engaged in the perpetration of a felony is itself warrant for additionally severe penalties. We are inclined to favor the proposed uniform law because of its sanity. Few will controvert the desirability and necessity of some restrictive measures and the need for uniformity among them. But many, especially those of us who measure the problem in its broader relationships, will be hesitant to favor anything which is an unfair and unwarranted transgression of individual rights. Nor should we forget that the place of the smallarms industry in the defense of the nation is a major consideration.

Several years ago representatives of the Ordnance Department stressed before legislative authorities the prime importance of the pistol and revolver for national defense. That this phase of the problem is always freely understood we doubt. There is a great clamor periodically from certain isolated sources for radical legislation aimed to outlaw the manufacture of such weapons. These sponsors, like zealous uplifters in other fields, can not distinguish between the use of a thing and its abuse. Theirs is the old nostrum that because some abuse all should be denied the use. The fallacy of the theory is quite obvious.

Thus it is that the uniform legislation is praiseworthy because it is reasonable. It proposes fair restrictions and insofar as it makes possession of a pistol by an unlicensed person at the time of commission of a crime prima facie evidence of intention to commit the crime, it should go a long way toward crime prevention. It would not molest the manufacture of weapons by responsible producers for legitimate trade in time of peace. Neither would it deny to the country the maintenance of the technique and experience of that long line of American smallarms manufacturers to whom the nation should be ever grateful. Let us keep the gun from the criminal, the drug addict and the mentally defective but do not let us infringe the right of the peaceful citizen to bear arms or of the manufacturer to make them. The value of both to the national defense is beyond computation.

"*Nine-hours' Supply of Artillery Ammunition!*"

An Editorial

ONE is tempted to say that almost too often, were that possible, have we had compared for us the pitiable lack of munitions preparedness existent in the United States at the time of our entry into the World War. We have heard so many times of the effort made in prewar years to shake us even slightly out of our twenty-year sleep that the telling now has something of the droll about it. The faithful few know it so well! Comparisons of the magnitude of World War battles with that of battles of other wars is no longer new. The mind best comprehends when it is given a comparative process of reasoning. Effective though such comparisons are, it remained for General Pershing in his long-awaited book to state the calamity with a starkness which startles by its forceful, direct and truthful manner. Describing the deplorable munitions situation as he found it when he assumed command in May 1917, he says we had less than 285,000 Springfield rifles, a few more than 400 light field guns, 150 heavy field guns and of auxiliary ammunition—except for the 3-inch gun—"we did not have enough to provide more than a nine hours' supply"! The folly of it and the pity!

Since our intention is to review in these pages similar aspects of General Pershing's book after its publication as such, one cannot proceed without again recalling the eternal graitude of a people to this great leader and others who were willing to undertake with stout hearts the duty of preparation under such adverse odds. But our nine hours' supply of artillery ammunition is, in itself, a subject for serious thought because it is a possible forecast of conditions as they may be again.

GENERAL Pershing's phrase speaks volumes. If it is true that some of us have learned a lesson from our munitions experience of the World War it is equally true that our people as a whole are again forgetting. If we have profited to the extent of our present superb system of planning for industrial mobilization it is equally obvious that the man in the street too often thinks of munitions in terms of profiteers and slackers. If we are taking time by the forelock in anticipating the requirements of "M-day" and our readiness to meet them, it is equally apparent that a general acceptance of the necessity of such things by our less munitions-minded brethren is not consummated. We are not so sure that millions who read General Pershing's description of conditions as he found them did not wag their heads as heads have wagged on other great historic occasions, serene in the ignorant bliss that others were at fault and that the responsibility was not theirs. The folly of that and the pity of it too!

What have we today with which to measure the degree of our munitions-minded progress? What tangible thing is there to grasp at and prove that another General of the Armies will find the munitions supply at hand less inadequate? The frank answer must be that while we have progressed far there is much that we have and much that we still require. We have a recognition of the necessity for munitions preparedness in the organic law of the land. We have a planning agency surprisingly alert and efficient. We have a technical and engineering organization producing types to baffle the gun makers of a generation ago. We have an appreciative and active industrial relationship with potential munitions producers in time of war. We have a group of professional and reserve officers in whose hands the management of war-time tasks should be safe. These, each and all of them, are assets beyond appraisal. But even these are not enough.

IF THE Pershing of another war is to be saved the anguish and delay of 1917-1918, and if our people are to be spared the needless waste of life, time, effort and money, there must yet be developed a proper understanding of munitions preparedness throughout the land. Take all your industrialists who understand, add to them the small group of Army officers and reservists of all branches, and we wager that of our one hundred twenty millions there are not, all told, a half million who have the proper concept of the situation. And there lies the cause, our time-sanctioned disinterestedness. Until the people—urban and rural, skilled and unskilled, remain constantly interested there is no assurance that our paper plans will be effective. Unless we preach from the housetops that national security and individual coöperation are indivisible our World War lesson was only half learned and a great book by a great man may again be written to recount how a nine hours' supply of artillery ammunition was responsible for our defeat.

To say this is not to conjure up hysteria, or a plea for militarism, an incentive for a race in armaments or a demand for great reserves of military supplies. Neither is it to urge the expenditure of huge sums on war stocks. Thanks to the unused production of 1918 we have certain war reserves but they will not last forever. In his annual report for the past year the Secretary of War, referring to this subject, says: "Since the World War an attempt has been made to accumulate and maintain war reserve stocks of many essential items which could not be immediately produced in the event of another major emergency. Each year has seen further depletion of these stocks by deterioration and budgetary limitations. At the present rate of depletion it will be but a matter of several years when there will be no properly balanced war reserve stocks on hand for immediate issue to mobilized man power. The lack of such war reserve stocks would make prompt and complete military effectiveness impossible in a given situation." What the country needs is a sympathetic *general* understanding of the problem. But "demobilization of war" is the theme of a well-meaning, representative group announced to assemble in the Nation's Capital the very day that General Pershing's discussion appeared in the press. A queer contrast and a not glowing tribute to the longevity of the popular memory! The folly of that and the pity of it, too!

Professional Notes

Ordnance Advisory Committee Considers Automotive Developments

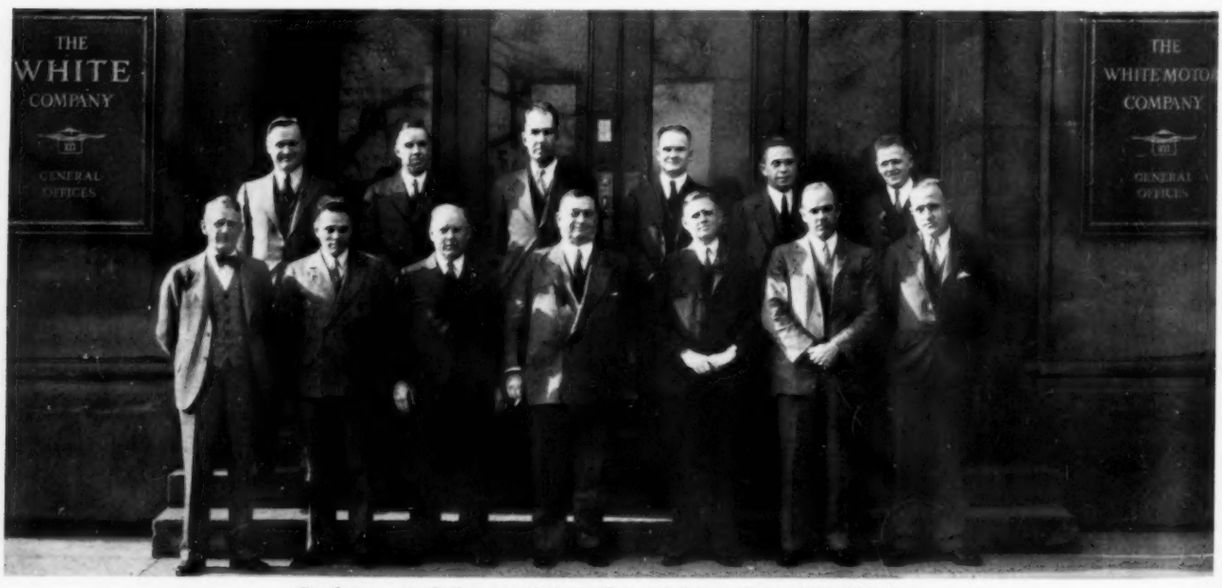
THE Ordnance Advisory Committee of the Society of Automotive Engineers held its 23rd semiannual meeting in Cleveland, Ohio, November 17, 18 and 19, 1930. A full and varied program made the meeting one of the best this important committee has held. The following members were present: A. F. Masury, Mack-International Motor Co., chairman; H. W. Alden, Timken-Detroit Axle Co.; George A. Green, General Motors Truck Corp.; A. J. Scaife, White Motor Co.; H. T. McDonald, Caterpillar Tractor Co.; A. W. Herrington, consulting engineer, and G. A. Round, Vacuum Oil Co.

The S. A. E. Ordnance Advisory Committee was first organized in 1919 upon the initiative of Maj. Gen. C. C. Williams, the distinguished war-time Chief of Ordnance, U. S. Army. The first meeting was held in Washington, D. C., September 15 and 16, 1919. The committee consists of prominent automotive engineers and leaders in the motor industry appointed by the Society to advise and assist the Ordnance Department in its automotive work.

Meetings are held semiannually at such places as offer opportunities to view activities having a bearing on the work of the committee. The meetings are attended by officers and engineers of the Ordnance Department engaged in the development of tanks, tractors, armored cars and other special automotive equipment for military use.

The Ordnance Department representatives present at the meeting were Lt. Col. C. M. Wesson, Maj. L. H. Campbell, Jr., Maj. W. A. Borden, Maj. E. A. Lynn, Capt. John K. Christmas, and Messrs. H. A. Knox, and W. F. Beasley, automotive engineers.

The sessions of the first day were devoted to two formal meetings at which were discussed the technical problems involved in the new developments which the Ordnance Department has under way. Some of the problems considered were maximum practical speeds for track-laying vehicles; the use of aviation engines in tanks; the present status of air-cooling; the practicability of various wheel-and-track vehicles; six-wheeled 4-wheel drive vehicles for cross-country transport; heavy duty transmissions with particular reference to means of gear shifting; lubrication of heavy duty engines; worm drive for fighting tanks; passenger versus truck chassis for use in heavy armored cars; possibilities of the new developments in half-tracked vehicles using rubber or other flexible tracks. Particular emphasis was laid on the desirability of the Ordnance Department developing special automotive vehicles only in the cases where military requirements dictate, leaving to the automotive industry, wherever possible, the development and manufacture of the enormous quantities of more or less standard vehicles. By intelligently compromising the military requirements with what is commercially available, the Army is given the full benefit of the rapid developments in our great automotive industry and there will be available at once, on the outbreak of war, a



Conferees at Ordnance Automotive Advisory Committee Meeting.

Front row, left to right: H. W. Alden, Timken Detroit Axle Co.; C. B. Veal, Assistant Secretary, Society of Automotive Engineers; A. J. Scaife, White Motor Co.; A. F. Masury, Mack-International Motor Co., Chairman; Lieut. Col. C. M. Wesson, Maj. L. H. Campbell, Jr., and Capt. J. K. Christmas, of the Ordnance Department, U. S. Army. Back row: E. A. Lynn, Cleveland District Ordnance Office; H. A. Knox, Office of the Chief of Ordnance; A. N. Herrington; H. P. McDonald, Caterpillar Tractor Co.; W. F. Beasley, Office of the Chief of Ordnance, and Maj. W. A. Borden, Executive, Cleveland Ordnance District.

large supply of reliable equipment. As a corollary to this the War Department should concentrate on the military equipment of a vehicle and leave the development of the integrated chassis and related matters to the industry.

The increasing importance of motorization and mechanization, on which great sums are being spent by foreign armies, has made the work of this committee of more importance each year. This is particularly so because the demands in military service as to power, speed, endurance and cross-country mobility are usually considerably ahead of the commercial requirements, and the advice of the leaders in the industry is needed to show the trend of development. If in no other way, the value of this committee to our Government is shown by the fact that, with the very limited funds available, we have consistently built tanks and other military automotive vehicles which are the equal and in many cases the superior of similar vehicles built abroad.

In addition to the formal activities of the committee there is considerable informal coöperation between the members and the Ordnance Department. The attitude of the Ordnance Department can best be expressed in the words of the Chief of Ordnance, Maj. Gen. Samuel Hof, who said recently: "The Ordnance Department appreciates the advice and coöperation of the S. A. E. Ordnance Advisory Committee, and I wish to thank the Society for its wholehearted and unselfish participation in this patriotic work, the full value of which may not be apparent until we confront another national emergency."

In addition to the formal meetings in Cleveland, the committee were the guests of the White Company under whose auspices the meeting was held. The committee and Ordnance Department representatives attended a meeting of the Cleveland Section S. A. E. on the evening of the 17th. They were tendered a luncheon by Mr. King C. White, Assistant Chief of the Cleveland Ordnance District, inspected the White Company plant and the U. S. Aluminum Company plant in Cleveland. In Akron they were the guests of the Goodyear Company and the Firestone Company. The activities included an inspection of the new giant Navy dirigible being built there by the Goodyear-Zeppelin Company, rides in the Goodyear airships and inspections of the tire factories.

C. M. WESSON,
Lieut. Col. Ord. Dept., U. S. A.,
Chief, Technical Staff, Ordnance Department.

The Museum and Library at Springfield Armory

IT is probably not as widely known as it should be that the Springfield Armory, Springfield, Mass., has a valuable collection of military and other small arms, ancient as well as modern, which has special technical value. There is probably nowhere else any such official collection of the several types of arms made at the national armories and used by the military forces of the United States from the American Revolution to date. These, with many other exhibits of technical, historical and sentimental value, are displayed at the Armory in its museum, which is used by the Armory personnel, and is visited by thousands every year. In addition, the Armory has in its Library many volumes bearing upon the technique and history of small arms and small arms manufacture, and it has also some important records of the history and work of the Springfield Armory from its establishment as a colonial depot in the year 1777.

All members of the Army Ordnance Association are asked to take note of these exhibits and to examine them when they are in the vicinity of the Armory. They are urged to remember that the Armory has no funds with which to build up its collections, and would greatly appreciate contributions of any suitable exhibits, especially those of technical value as illustrating marked steps forward in the development of arms at any time during the past. The Armory is especially desirous of finding and acquiring the following special exhibits:

U. S. Flint Lock Smooth Bore Musket manufactured at Springfield Armory prior to 1799. One of 1795 manufacture if possible.

U. S. Flint Lock Smooth Bore Musketoons manufactured at Springfield Armory. These had short barrels corresponding to carbines.

U. S. Flint Lock Rifles manufactured at Springfield Armory prior to 1837. Particularly one manufactured in 1814.

Quite possibly some members of the Army Ordnance Association have articles or books of this kind which they treasure, but which, after their death, would be of no interest or value to the heirs, and it is suggested that Springfield Armory Museum and Library be named as legatee therefor in their wills.

In the past very valuable contributions to the Library have been made by Colonel Stanhope E. Blunt and Colonel Kenneth Morton. The donors' names are inscribed in the books. Donations to the Museum have been too numerous and too remote to recite them. Present practice is to acknowledge donations and to record the name of donor.

J. W. JOYES,
Colonel, Ord. Dept., U. S. A.,
Commanding, Springfield Armory.

Explosives Courses at Stanford University

EXCLUSIVE of the regular Reserve Officers Training Corps courses in ammunition and explosives, there are now embodied in the curriculum of the Mining Department of the School of Engineering at Stanford University two courses which have a direct bearing on the training of Ordnance officers. These courses are: A two-unit theoretical course, "Powders and Explosives," and a two-unit laboratory course, "Explosives Laboratory."

They are open to selected engineering students and to members of the R. O. T. C. Ordnance Unit who desire additional explosives work. The laboratory is also used in the training of the classes of Ordnance reserve officers who, for some years past, have been brought together each year at Stanford University for an intensive two weeks active duty period.

The theoretical course in "Powders and Explosives" is a lecture and study course covering the following subject matter:

(1) General discussion of organic chemistry: aliphatic structures; the methane series of hydrocarbons; isomeric substances; valencies; radicles; unsaturated hydrocarbons; the alcohols; aromatic structures, etc.

(2) The theory of nitration: the complex cellulose molecule; Eder's, Vielle's and Mendelief's researches on nitration; mixed acids used; nitrogen contents and solubilities obtainable; nitration of aromatic structures.

(3) The theory of explosive reactions: fundamental concepts of heats of formation, heat liberated, gram molecule, molecular volumes, specific heats, potential, etc.; the effects of an explosion and the nature of the explosive wave; numerical computation of the potential.

(4) The theory of explosive reactions: double base powder composition, a computation of the decomposition products formed, heat liberated by a gram molecule of substance at constant pressure and at constant volume, and the temperature of the explosion; characteristic equations for perfect and for explosive gases, and the pressure developed in a closed chamber.

General View, Explosives Laboratory, Stanford University.

(5) Colloids: characteristics; crystalloidals; methods of measuring viscosity and plasticity; electric charges carried by colloidal particles, etc., and application of colloidal chemistry to powder manufacture.

(6) The production of ether in the ether-alcohol plant: theory and the chemistry stated; a step by step description of the ether and alcohol plant as it operates as a part of a powder factory.

(7) Smokeless powder manufacture: raw materials; preparation of the cotton; preparation and handling of the acids used; and the process of nitration.

(8) Smokeless powder manufacture: sour boiling of the nitrated cotton; pulping; poaching; packer's screen; wringing of the pyro, and control tests by the laboratory.

(9) Smokeless powder manufacture: dehydration; block breaking; mixing; preliminary blocking; screening; final blocking; graining; and inspection tests.

(10) Smokeless powder manufacture: cutting grains of powder by the Navy type and band type cutters; solvent recovery procedure; theory of solvent loss; study of drying tests at elevated temperatures; air and water drying processes; blending and packing of powder; inspection tests.

(11) Smokeless powder manufacture: granulations and compositions of powders; pilot lots; effects of variations in composition; test firings; acceptance tests.

(12) Stability and inspection tests for smokeless powder: causes of decomposition; effects of heat and moisture on powders; detailed description of the continuous 65.5° C. surveillance tests and 65.5° C. and 135° C. heat tests.

(13) Manufacture of black powder: raw materials used; description of each step of manufacture.

(14) Military high explosives: general characteristics; uses; positions in the explosive train; classification as to composition; the effects of explosives; measurements of the rate of detonation, friction and drop tests, ballistic pendulum test, sand test, etc., and effects of density, confinement, etc.

(15) Manufacture of TNT: chemistry involved; raw materials; detailed description and discussion of each step of manufacture; inspection tests.

(16) Manufacture of tetryl: chemistry involved; raw materials; detailed description of manufacture; tests; comparative sensitivity, stability, etc.

(17) Manufacture of mercury fulminate, cyclonite, and PETN: chemistry involved; description of the plant procedure; raw materials.

(18) Manufacture of picric acid and ammonium picrate: chemistry; raw materials; plant procedure.

(19) Nitrogen fixation: discussion of the sources of inorganic and organic nitrogen; nitrogen fixation plants—the arc, cyanimide, and Haber processes in detail.

Another View, Explosives Laboratory, Stanford University.

The laboratory work in explosives, as at present conducted, consists of the following experiments: (1) Fractional distillation of fusel oil; (2) preparation of ethyl acetate; (3) preparation of aniline; (4) preparation of nitrobenzine; (5) preparation of phenol; (6) compression tests and measurements of smokeless powder grains; (7) preparation of nitrocellulose; (8) determination of ether-alcohol insoluble material in nitrocellulose; (9) standardization of nitrometer and determination of the nitrogen content of nitrocellulose; (10) heat test at 135° C. for stability of smokeless powder; (11) determination of specific gravity of smokeless powder; (12) determination of ash in pyrocellulose; (13) determination of moisture and volatiles in smokeless powder; (14) determination of diphenylamine in smokeless powder; (15) heat test of nitrocellulose at 65.5° C. with potassiumiodide starch paper; (16) preparation of picric acid; (17) testing

of ethyl alcohol and ether; (18) preparation of ammonium picrate (explosive D), and (19) sand test bomb.

Materials and apparatus are on hand for expansion of the work in the laboratory, but the schedule has proved sufficient to cover the time of one quarter of the academic year.

This laboratory and the courses it makes possible are distinctly Ordnance enterprises and will prove highly useful. The courses are available for regular officers taking the 2-year course at Stanford University, Standard students taking the Ordnance R. O. T. C. course at Stanford, Ordnance reserve officers attending the Stanford Special Ordnance School (an abbreviated 2-weeks course), and engineering students at Stanford who may elect the courses as part of their Engineering School curriculum leading to a degree.

I. A. LUKE,
Capt. Ord. Dept. U. S. A.,
Stanford University.

Improvements in Blank Ammunition

BLANK ammunition is used in artillery weapons for saluting and for any other firing which may be necessary to obtain a noise without projecting a missile from the muzzle of the piece. Eleven weapons varying in caliber from the 37-mm. field gun to the 4.7-inch field gun, inclusive, have been authorized as saluting guns. Many thousands of rounds of saluting ammunition are fired every year in our Army service.

Because of excessive transportation costs, it is not practical to manufacture blank ammunition complete in an Army arsenal and forward it to the Army post where it is to be used. In the past the round of blank ammunition has consisted of a short cartridge case, loaded primer, loose black powder charge and a felt wad used to close the mouth of the case. Paint was used to seal the open end of the case after the felt wad was inserted. It has been the practice to assemble these rounds at the Army post as needed. The cartridge case could be used repeatedly, and loaded primers, felt wads and loose black powder in the usual shipping kegs were issued separately to the post. Fig. 1 shows the assembly of this round.

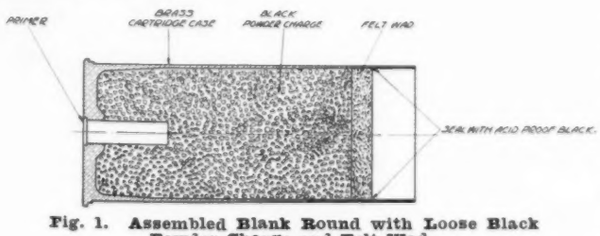


Fig. 1. Assembled Blank Round with Loose Black Powder Charge and Felt Wad.

This method of preparing blank ammunition proved to be quite unsatisfactory and unsafe. Several accidents have resulted from the handling of the loose black powder and from the poor closure of the mouth of the case resulting from the use of a felt wad.

About three years ago the Ordnance Department actively undertook a study of blank ammunition with a view to obtaining a safer and more satisfactory round and a safer method of assembly. It was obvious that loose black powder should be handled only by experienced personnel under carefully controlled conditions, and therefore it was desirable that the powder charge be put up in a bag at an arsenal or a storage depot and issued to the field station as a unit. As the felt wad also had shown itself unsatisfactory it was considered that a better method of closing the mouth of the case should be sought. After considerable experimental work a chipboard cup with slightly tapered sides was designed and tried out with very satisfactory results. The sides of this cup are tapered to insure a tight fit in the cartridge case even when a case is used which has a taper on the inside wall. The side walls of the chipboard cup are coated with cement before the cup is inserted in the case. This cement thoroughly seals the round against the entrance of moisture and at the same time makes it possible to transport the round with the open end of the case downward if occasion requires without danger of spilling the charge.

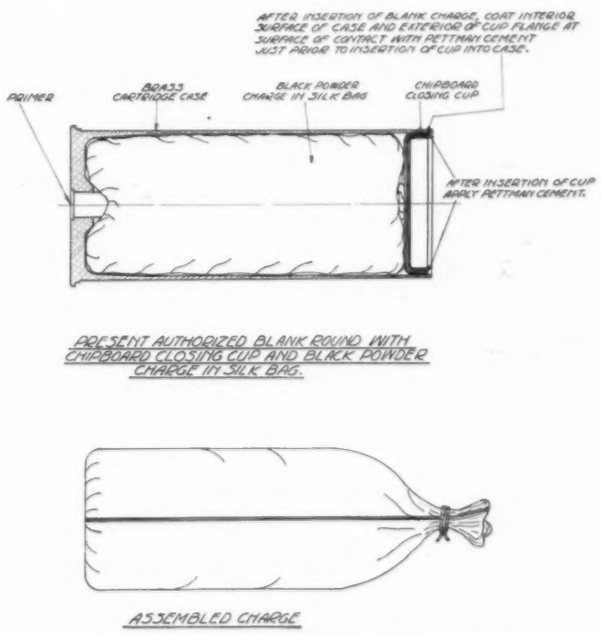

AFTER INSERTION OF BLANK CHARGE, COAT INTERIOR SURFACE OF CASE AND EXTERIOR OF CUP FLANGE AT SURFACE OF CONTACT WITH RETTMAN CEMENT JUST PRIOR TO INSERTION OF CUP INTO CASE.
PRIMER
BRASS CARTRIDGE CASE
BLACK POWDER CHARGE IN SILK BAG
CHIPBOARD CLOSING CUP
AFTER INSERTION OF CUP APPLY RETTMAN CEMENT.
PRESENT AUTHORIZED BLANK ROUND WITH CHIPBOARD CLOSING CUP AND BLACK POWDER CHARGE IN SILK BAG.
ASSEMBLED CHARGE

Fig. 2. Above: Present Authorized Blank Round. Below: Assembled Powder Charge.

This new method of assembly of blank ammunition is shown in Fig. 2. This assembly has now been adopted as standard for all saluting ammunition. The black powder charge will be incorporated in the cloth bag at the arsenal or storage depot and issued to the using service in hermetically sealed powder cans. The loaded primers, chipboard cups and cement will also be issued as separate items. The cartridge cases will be retained in the field station and used repeatedly as was done with the previous assembly.

It is believed that this new method of assembling blank ammunition will eliminate or at least materially reduce accidents and at the same time produce a round which is more satisfactory in every way to handle and use.

H. M. BRAYTON,
Ordnance Engineer,
Picatinny Arsenal.

Training and Tactical Mission of the Mechanized Force

THE Secretary of War has issued instructions to the commanding officer of the mechanized force, which is now being assembled at Fort Eustis, Virginia, assigning to this

newest unit of the Army its tactical role and training mission. The tactical role will be based on several factors. For its size the mechanized force has great strategic mobility, considerable tactical mobility in favorable terrain, considerable offensive power but limited defensive power. The effective employment of its offensive power is, however, limited by certain terrain features. Careful consideration of the proper tactical missions to which the force may be assigned and to that assigned to neighboring troops must, therefore, constantly be borne in mind.

Organized on the theory that modern tanks on account of their armament, speed, marching radius and mechanical reliability are now capable of extended maneuver beyond the immediate support of divisional infantry, the proper role of the mechanized force will be those tactical missions which present an opportunity for the use of these characteristics. In acting with troops of other arms, its missions will be those which call for the use of mobility and striking power, such as the seizure and temporary retention of distant key points; attacks which involve turning and enveloping movements where the elements of speed, surprise and direction are essential; counter-attacks; missions and advance, flank or rear guard; missions in the break-through and exploitations of such a maneuver. The employment of this force will in no way diminish the role of Infantry tanks.

In the conduct of the training of the new force its mission will be that of a tactical laboratory for the determination of the proper tactics which can and must be used in the maneuver of fast tanks supported by other mechanized or motorized arms. In addition, it will test experimental equipment in the field and will be of great value as a field agency to determine the tactical characteristics required of armored vehicles and their auxiliaries.

To this end the instructions state that the drills, field exercises and maneuvers will constantly tend toward the establishment of the technique of command, communications, reconnaissance and security, attack and defense, employment of auxiliary arms, field administration, supply and logistics. Each drill, field exercise and maneuver will be framed so as to develop certain definite features of technique.

From January 1 to March 31 the force will engage in unit training and in combined drills to perfect the tactical team-work of the force as a whole. From April 1, 1931, to June 30, the force will engage in maneuvers and field exercises with troops of other arms.

The use of the mechanized force in conjunction and coöperation with Air Corps units has not as yet been worked out and further arrangements will be made for this phase of the training.

The mechanized force will be administered in the same manner as a separate regimental command. Such powers as are now authorized under the regulations for a regimental commander have been assigned to the commanding officer of the force.

An Air Division to Maneuver

FOR the first time in the history of military aviation in this country, an organization which might rightfully be called a reduced strength air division will be put into the air at one time, and under one command will go through a period of extensive maneuvers when an American air division is concentrated at Wright Field, Ohio, in May.

At present, with the highly efficient but small Air Corps, the largest units now in the field are the various groups; although one bombardment wing, consisting of a bombardment group and its protective pursuit group, is now in the process of formation. The Air Corps, however, has often consolidated the various groups into provisional wings during the annual maneuvers, and has even had an air brigade in operation at Langley Field during the six months battleship bombing tests in 1921.

The concentration of military aircraft and personnel in 1931 will outstrip any of these provisional organizations of the past in magnitude and will therefore justify its title of air division. Such an organization is essentially a war-time one, being the largest air organization that this country would have under one command in time of war; and would be in addition to the various smaller organizations assigned or attached to field armies, corps or divisions. The air division to be formed in May will be, of course, the war-time organization skeletonized in planes and personnel by peace-time conditions.

Normally, a full war-time air division would consist of over 4,000 officers, almost 30,000 enlisted men, and over 2,200 airplanes. In 1931, it is expected to concentrate 600 officers, 500 enlisted men and 584 airplanes, or one-seventh the war-time strength of officers, one-sixtieth of enlisted strength and one-fourth of the required number of airplanes.

As previously outlined by the Assistant Secretary of War for Aeronautics, Hon. F. Trubee Davison, the air units at the various Air Corps stations throughout the country, including flights from various National Guard observation squadrons, will move by air to Wright Field, Ohio, concentrating there and going through the first phase of their combined maneuvers, this phase consisting of the welding together of many units into the air division. The three days allotted before the air division moves on to New York will make this no small task, and it is only possible due to experience gained by the Air Corps on previous annual maneuvers or field exercises.

The division will spend several days in the metropolitan area of New York in carrying out the final phases of the field exercises, moving on to New England and down to the Chesapeake Bay area as the exercises continue. The division will be in operation for about two weeks.

Organizations making up the division will be as follows: headquarters staff with 50 airplanes; 1 pursuit wing, consisting of three pursuit groups with 135 airplanes; 1 bombardment group, consisting of 6 squadrons with 40 airplanes; 1 observation wing, consisting of 4 observation groups with 111 airplanes, plus National Guard squadrons attached; 1 attack group, with 50 airplanes, and 1 transport group, with 40 airplanes.

The headquarters staff, as befits the air division, will be a mobile flying organization, the staff officers flying their airplanes and accompanying the division as an integral part thereof on all its movements.

Concentrating and maneuvering as it will, in the thickly populated areas of this country, the people in the locality will be afforded an opportunity of seeing the largest concentration of air units which has as yet been held here. Maneuvers of this type have a most important bearing on the tactical efficiency of the Army Air Corps and serve to demonstrate the mechanical sufficiency of the matériel in use.

Association Affairs

New Members

THE following were admitted to membership in the Association since the last issue of ARMY ORDNANCE: H. V. Anderson, Minneapolis, Minn.; Louis S. Baker, Parlin, N. J.; J. Mercer Barnett, Fairfield, Ala.; Albert A. Beard, Woodhaven, L. I., N. Y.; J. G. Belding, Augusta, Ga.; T. H. Benners, Birmingham, Ala.; W. Russell Borneman, Pottstown, Pa.; E. C. Bothwell, Pittsburgh, Pa.; Warren C. Bruce, St. Louis, Mo.; Paul H. Brueckner, Baltimore, Md.; M. W. Bush, Birmingham, Ala.; James A. Caselton, St. Louis, Mo.; H. H. Chambers, San Leandro, Calif.; Chester W. Clark, Berkeley, Calif.; John Cleage, Jr., Birmingham, Ala.; John F. Coneybear, New York, N. Y.; Silas H. Corey, Wenatchee, Wash.; Frank H. Crockard, Woodward, Ala.; Augustine J. Cunningham, Rochester, N. Y.

H. B. Deal, St. Louis, Mo.; Prince DeBardeleben, Birmingham, Ala.; George Deethardt, San Leandro, Calif.; Floyd C. Devenbeck, Pittsburgh, Pa.; Milton H. Fies, Birmingham, Ala.; L. W. Fischer, Detroit, Mich.; L. S. Fletcher, Watertown, Mass.; T. B. Forsburg, Dada City, Fla.; Leonard F. Fuller, Palo Alto, Calif.; L. E. Geohegan, Birmingham, Ala.; Chas. F. Gilbert, Jr., St. Louis, Mo.; J. W. Glover, Marietta, Ga.; Norris B. Gregg, Jr., New York, N. Y.; Robert Gregg, Atlanta, Ga.; John J. Grimes, Birmingham, Ala.; Fred H. Groen, Chicago, Ill.

Horace Hammond, Birmingham, Ala.; Svarre Hazelquist, Seattle, Wash.; Carl E. Heimbrodt, Chicago, Ill.; Thad Holt, Birmingham, Ala.; L. Gale Huggins, Birmingham, Ala.; R. I. Ingalls, Birmingham, Ala.; C. E. Ireland, Birmingham, Ala.; William B. Johns, Atlanta, Ga.; J. T. Johnson, Jr., Birmingham, Ala.; T. J. Kidd, Birmingham, Ala.; Thos. E. Kilby, Anniston, Ala.; Karl L. Landgrebe, Birmingham, Ala.; Wm. J. Landherr, Philadelphia, Pa.; P. T. Laws, Birmingham, Ala.; M. P. Ledbetter, Birmingham, Ala.; Myron Leedy, Fort Thomas, Ky.; Robert A. Lewis, Birmingham, Ala.; Maxwell R. Loechel, Philadelphia, Pa.

Bernard Mallon, Jr., Birmingham, Ala.; Thomas W. Martin, Birmingham, Ala.; Edward P. Mechling, Cambridge, Mass.; Frank J. Merryman, Corvallis, Ore.; R. A. Mitchell, Birmingham, Ala.; W. D. Moore, Birmingham, Ala.; George M. Morrow, Jr., Birmingham, Ala.; Hugh Morrow, Birmingham, Ala.; Lindley C. Morton, Birmingham, Ala.; Wm. C. Oberg, Pittsburgh, Pa.; W. H. Oldham, Birmingham, Ala.; Marion B. Penn, Birmingham, Ala.; J. C. Persons, Birmingham, Ala.; Ashton R. Peyton, Birmingham, Ala.; Frank O. Pierson, New York, N. Y.

Erskine Ramsey, Birmingham, Ala.; Cyrus K. Rickel, Fort Worth, Texas; Arthur L. Roberts, Jr., Sparrows Point, Md.; E. Hill Roberts, Harrisburg, Pa.; Robert E. Rogers, Jr., Oklahoma City, Okla.; R. H. Roush, Princess Anne, Md.; Raymond H. Rudrauff, Philadelphia, Pa.; C. F. W. Rys, Pittsburgh, Pa.; James A. St. Louis, New York, N. Y.; Edward L. Sayers, Anniston, Ala.; Robert Schlieve, Seattle, Wash.; Warren H. Schnable, Bethlehem, Pa.; F. H. Schubert, Affton, Mo.; Landers Sevier, Birmingham, Ala.; B. F. Shepherd, Phillipsburg, N. J.; A. M. Shook, Jr., Birmingham, Ala.; R. E. Smith, Birmingham, Ala.; Henry F. Soper, Greenfield, Mass.; John C. Stanley, Bridgeport, Conn.; R. C. Stobert, Birmingham, Ala.; H. C. Stockham, Birmingham, Ala.; Philip G. Strong, New York, N. Y.; William E. S. Strong, New York, N. Y.; George Sweeney, Berkeley, Calif.

G. M. Taylor, Aberdeen Proving Ground, Md.; T. D. Temple, Fairfield, Ala.; D. A. Thomas, Birmingham, Ala.; Harrison M. Thomas, Pittsburgh, Pa.; Robert J. Travis, Savannah, Ga.; R. H. Trese, Detroit, Mich.; W. D. Tynes, Birmingham, Ala.; H. M. VanCleve, Bethlehem, Pa.; Granville A. Waters, University City, Mo.; Gordon B. Welch, Philadelphia, Pa.; Maurice B. Welsh, Philadelphia, Pa.; Oscar Wells, Birmingham, Ala.; Ralph McL. Wood, Birmingham, Ala.; George W. Woodruff, Birmingham, Ala.; Charles F. Wright, Jr., New York, N. Y.; and S. L. Yerkes, Birmingham, Ala.

Necrology

SINCE publication of the last issue of ARMY ORDNANCE, notice has been received of the death of the following members: H. Ainsworth, Moline, Ill.; H. Grubb, Wilmington, Del.; J. M. Hansen, Pittsburgh, Pa.; Carl A. Meissner, New York, N. Y.; Wm. H. Nichols, New York, N. Y.; Samuel B. Sheldon, Duluth, Minn.; Ross H. Skillern, Philadelphia, Pa.; H. F. Wahr, Pittsburgh, Pa., and Edw. R. Wood, Jr., Philadelphia, Pa.

St. Louis Post Meeting

THE regular annual meeting of the St. Louis Post, Army Ordnance Association, was held on December 1, 1930, at the Jefferson Hotel, St. Louis. Col. Harry Scullin, Ord. Res., President of the Post and Assistant Chief of the St. Louis Ordnance District, presided. About one hundred members and guests were present.

The honor guests and principal speakers were the Assistant Secretary of War, Col. Frederick H. Payne, and the Chief of Ordnance, U. S. Army, Maj. Gen. Samuel Hof. Colonel Payne's address was devoted largely to the present status of war planning in the office of the Assistant Secretary of War. He outlined the organization of his office and its planning functions in the supervision of Army supply in the event of emergency. He also discussed the broader features of the supervisory regulations which would apply in the control of industry in war.

General Hof, in describing the principal functions and current activities of the Ordnance Department, emphasized the necessity for close coöperation between the Department and industry and congratulated the engineers and manufacturers of St. Louis on their evidence of such splendid spirit.

Preceding the dinner, the Assistant Secretary was the guest at a meeting of the Advisory Board of the St. Louis District held at the Noonday Club at which Mr. M. E. Singleton, the St. Louis District Chief, was host. Some twenty prominent men of St. Louis, including the members of the Advisory Board, attended. Following the luncheon a review of troops at the Jefferson Barracks was given in honor of the Assistant Secretary.

Colonel Scullin, President of the St. Louis Post, is one of the most active and interested officers of the Army Ordnance Association. He has done much to stimulate interest in the important work of munitions preparedness in that area and as toastmaster at the annual meeting he presided with his usual good grace.

During the meeting the results of the recent annual election of officers and directors of the Post were announced by Maj. F. W. L. Peebles, Chairman of the Committee on Nominations and Elections. The following officers were elected for the ensuing term: Col. Harry Scullin, president; Lt. Col. E. D. Campbell, vice-president; Messrs. J. M. Kurn, J. W. Jarboe, A. J. Davis, E. D. Nims, M. E. Singleton, W. F. Carter, J. M. Olin and H. I. Finch, directors; and Capt. L. J. Dillon, secretary-treasurer.

Washington Post

THE regular fall meeting of the Washington Post, Army Ordnance Association, was held at the Army and Navy Country Club, Friday, November 21st, at 12:30 P. M. The meeting was a joint gathering with the officers of the Army Air Corps stationed in and about Washington. Lieut. Col. C. G. Mettler, President of the Washington Post, presided.

The guests of honor included the Assistant Secretary of War, Col. Frederick H. Payne, Maj. Gen. James E. Fechét, Chief of Air Corps; Brig. Gen. Benjamin D. Foulois, Assistant Chief of Air Corps, and Brig. Gen. William H. Tschappat, Assistant to the Chief of Ordnance. The principal speaker was Col. E. A. Deeds who delivered one of the best addresses ever presented before the local post. Colonel Deeds is well known for his outstanding war service both for the Air Corps and the Ordnance Department and in his address stressed the importance of industrial cooperation on the part of both services and the need for maintaining appropriations for development and production of military supplies. The address was enthusiastically received by the eighty-odd members present.

Boston Post

A JOINT meeting of the Boston Post, A. O. A., and Reserve Ordnance Officers of the territorial and branch assignment groups in and around Boston was held November 7, 1930. Lieut. Col. R. F. Whitelegg, President of the post, presided. A goodly representation including regular officers from the Boston Supply Base and reserve officers from the Massachusetts Institute of Technology was present.

The principal discussion included a plan for activities of the post for the coming year. It was decided to hold meetings at night. Mr. Hesselschwerdt, secretary of the local post of the Massachusetts Institute of Technology, described the ordnance training which members of the R. O. T. C. at that institution receive. A committee was appointed to consider the possibility of holding biweekly luncheons at the Walker Memorial.

Cincinnati Post

THE regular annual election of officers of the Cincinnati Post, Army Ordnance Association, was held December 20, 1930. The following officers were elected: E. A. Muller, President; S. M. Rowe, Vice-President; C. L. Harrison, C. W. Verity, W. C. James and J. T. Faig, Directors.

The above officers will be installed at the regular annual meeting of the post.

Pittsburgh Post

THE Assistant Secretary of War, Col. Frederick H. Payne, and the Chief of Ordnance, Maj. Gen. Samuel Hof, paid their first official visit to Pittsburgh on November 14 and 15, 1930, where they were guests of honor at a dinner at the Duquesne Club given by members of the Pittsburgh District Advisory Board to which 150 industrialists and reserve officers were invited. Mr. Homer D. Williams, Chairman of the Advisory Board, was toastmaster and introduced the guests of honor.

At the dinner announcement was made of the resignation of Mr. Dravo as Chief of the Pittsburgh Ordnance District and the appointment of his successor, Mr. Frank B. Bell, President of the Edgewater Steel Company. In making the announcement Mr. Dravo stated he felt he had done one of his best jobs for the Ordnance Department in recommending Mr. Bell as his successor. He thanked all members of the Advisory Board for their coöperation during his term as Ordnance District Chief and expressed his appreciation for the great support received from all members of the Ordnance Department at Washington.

Mr. Bell said that he was very glad to accept the appointment and hoped that he would be able to have the coöperation of the Advisory Board as fully as had Mr. Dravo, that he felt a real task was presented him to follow in the footsteps of his predecessor and that he would try to the best of his ability to fulfill the requirements. In presenting the certificate of appointment as district chief to Mr. Bell, General Hof also confirmed the appointment of Mr. Dravo as a member of the Advisory Board. In speaking of Mr. Dravo's resignation General Hof said in part:

"I need not take time to sum up for you the enormous effort of the Pittsburgh District in the production of steel for cannon, for recuperators, and for projectiles, in the machining of shell, in the making of optical instruments and in the thousand and one things of that kind that were piled upon Mr. Dravo's office after we entered the war. However, I do not believe many of us thought of Pittsburgh during the war as being the source of materials for high explosives, but we soon found that certain by-products of coke ovens were essential in their manufacture. The Pittsburgh District also played a big part in the furnishing of these materials.

"The achievements of this district in going forward with its many and varied activities until work was halted on November 11, 1918, were outstanding and are among the signal accomplishments of the Ordnance Department during the war.

"My first intimate contact with Mr. Dravo came after the Armistice when the United States began to settle the claims of the World War. As Chairman of the Pittsburgh Ordnance District Claims Board, Mr. Dravo rendered invalu-

able services to the Nation in adjusting equitably over two hundred million dollars worth of outstanding contracts in the Pittsburgh District.

"In 1922 when General Williams decided to reëstablish the districts for decentralization of planning in preparation for a future emergency, he had before him the memory of Pittsburgh's effective work.

"On August 9, 1922, Mr. Dravo became District Chief of the reorganized Pittsburgh Ordnance District. For over eight years he has filled this position with great credit and has often assisted the Ordnance Department by his constructive suggestions.

"Mr. Dravo is today resigning as chief of this district. I regretfully and reluctantly accept his resignation from this office, and I wish to extend to him the heart-felt thanks of the Department for his splendid work.

"Mr. Dravo's forceful personality, together with his prominence and large intimate acquaintance with the leading industrial executives of Pittsburgh enabled him to push the procurement planning of the Department more efficiently than it could have been done in any other way.

"It is difficult to express the value to the Ordnance Department of such men as Mr. Dravo. There is not much the Department can do in recognition of their services. But the Department took great pleasure in recommending for Mr. Dravo the Distinguished Service Medal. This was awarded by the Secretary of War in 1919 for the intelligent and enthusiastic manner in which he effected coöperation between the Ordnance Department and manufacturers in his district, thereby attaining the maximum production of munitions in a minimum of time.

"I am delighted to say, however, Mr. Dravo is not leaving us entirely. He has consented to become a member of the Advisory Board and in this capacity we will be able to avail ourselves of his advice.

"As we are losing the active services of Mr. Dravo, we realize that the work of the district must be carried on by an experienced man of wide knowledge of local conditions. At the suggestion and through the efforts of Mr. Dravo and many others, we have had the good fortune to secure as Mr. Dravo's successor Mr. Frank B. Bell, well known to you as President of the Edgewater Steel Company, and well known to us in Washington as Assistant District Chief of the Pittsburgh District.

"In peace times, Mr. Bell's company (The Edgewater Steel Company) built locomotive tires. Though this company had never had any experience in making or forging ordnance gun steel and did not have the facilities nor the working force to perform this special task, it undertook with excellent success contracts for forgings for the 155-mm. gun and the 240-mm. howitzer. At the close of the war when operations were discontinued, the Edgewater Company had produced 180 complete guns and 75 complete howitzers, besides many miscellaneous gun forgings. This company also produced all of the breech-ring forgings for the Government's 155-mm. gun program. This was a complicated and difficult forging and through the energy and ingenuity of Mr. Bell, a novel and very successful method of making it was developed. This process was indeed so successful that ordnance officers from several foreign countries visited the plant to study the operation.

"I take great pleasure in announcing the appointment of Mr. Frank B. Bell to succeed Mr. Dravo as Chief of the Pittsburgh Ordnance District.

"The Ordnance Department will have a sense of security in the knowledge that the activities of the Pittsburgh District, which have thus far been guided so well by Mr. Dravo, will be taken over and supervised by one who has a keen understanding of our problem and who through his association as Assistant District Chief is aware of our progress in planning for the mobilization of industry in the event of an emergency."

Association Membership

THE Association has its government vested in a Board of Directors, six of whom are elected by general ballot of the entire membership, for terms of four years, and one director representing each local post, the latter being elected by the respective posts. The officers, with one director elected by the Board of Directors, constitute the Board of Trustees which has the active management of the affairs of the Association. The president and vice-presidents are elected every two years by general ballot and the counsel, treasurer and executive secretary are appointed by the Board of Directors. The Association was incorporated in 1928 under the laws of the District of Columbia.

Over 90 per cent of the membership of the Association consists of executives and engineers of American industry who are cognizant of the importance of industrial preparedness. These gentlemen who, through affiliation with the Association are kept informed of current development of munitions, constitute a large portion of the civilian nucleus upon whom our Government will depend for the manufacture of ordnance in time of emergency.

The following extracts from the Constitution and By-Laws of the Association define the several classes of membership.

"SEC. 1. Full membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"SEC. 2. Life membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"Life membership shall continue during the lifetime of the life member and shall expire at death. It shall not be transferable."

"SEC. 3. Student membership in the Association shall be open to all men who are American citizens and who are students in technical schools or colleges. Student members shall not vote or hold office in the Association.

"SEC. 4. Group membership in the Association shall be open to all individuals, firms, companies and groups controlled by American citizens who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"Group members shall have the privilege of nominating ten men for full membership in the Association, and members thus nominated shall pay no dues."

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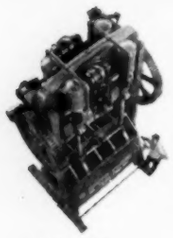

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Digest of Ordnance Patents

THE following digest of recent ordnance patents is by W. N. Roach, Chief, Patent Branch, Office of the Chief of Ordnance. Letters patent have been issued:

To Elmer A. Sperry and Elmer Meitner, assignors to the Sperry Gyroscope Company, No. 1,755,340 for a director firing system. One of the main objects of this invention is the provision of novel means for causing a receiving instrument to lead or lag behind a transmitting instrument in order to introduce a correction in the transmitted bearing.

To Samuel G. Green, Office of the Chief of Ordnance, No. 1,757,244 for a recoiling cradle for mounting machine guns.

To George M. McCann, Office of the Chief of Ordnance, No. 1,757,257 for a breech structure of guns having a retaining ring for the loose liner.

To Karl Petschenig, assignor to the firm of C. P. Goerz, Optische Anstalt Aktiengesellschaft, No. 1,757,874 for a sound-ranging device for locating aircraft.

To Julius Becker, Heinrich Just, and Hermann Hort, assignors to Fried Krupp Aktiengesellschaft, No. 1,758,273 for a sighting device for guns. The invention relates to a mounting for the sight so constructed as to eliminate the error which occurs due to the inclination of the horizontal trunnions in elevating the gun barrel.

To Capt. Hiram B. Ely, formerly of Frankford Arsenal, No. 1,758,393 for a specific form of mounting the horn in a sound-locating apparatus.

To Christian von Hofe, assignor to C. P. Goerz, Optische Anstalt Aktiengesellschaft, No. 1,762,102 for a sound-ranging device.

To Adolf Steinle, assignor to the N. V. Nederlandsche Instrumenten Compagnie, No. 1,762,800 for a fire-control apparatus for firing at movable targets.

To Hermann Schuler and Fritz Herlach, assignors to Rheinische Metallwaaren-Und Maschinenfabrik, No. 1,763,988 for a wheel gun carriage the trail of which provides a gun platform on which there is mounted a pedestal adapted to be tipped over to rest upon the axle of the carriage when in traveling position.

To Thomas A. Conlon, Office of the Chief of Ordnance, No. 1,764,038 for a novel means for relieving the springs of the weight of the gun carriage when the gun is to be fired.

To Ignaz Pechan, assignor to Czechoslovak Company: C. P. Goerz, Optische Anstalt Aktiengesellschaft, No. 1,771,345 for an aiming telescope constructed as a breech sight.

To Karl Stratomeyer, assignor to Naamlooze Vennootschap: Hollandsche Industrie-En Handelmaatschappij, No. 1,771,663 for a gun mount. This invention relates to means for coupling the trail to the front carriage.

To Capt. G. M. Wells, and George M. McCann, Office of the Chief of Ordnance, No. 1,772,505 for a gun with removable liner.

To Maj. Gladeon M. Barnes, Watertown Arsenal, No.

1,772,597, for loose liners constructed from centrifugally cast tubing.

To Capt. Hiram B. Ely, No. 1,774,826 for the construction of a mount for the horns of a sound ranging device.

To Samuel G. Green, No. 1,782,610 for a gun carriage. The invention relates to a specific rack and pinion connected between the gun carriage and the wheels, which permits the weight of the carriage to be taken off the springs and wheels when the gun is in action.

To Thomas A. Conlon, No. 1,779,531 for a specially constructed mobile mount for antiaircraft guns, provided with suitable outriggers.

TO Paul R. Dindinger, No. 1,755,635 for a gun sight. The device covered by this patent is a front sight so constructed that it provides a sight opening about which there is a clear view.

To Samuel Wiley, Picatinny Arsenal, No. 1,751,271, for a pistol for discharging signal cartridges. It has a projection adapted to enter the recess in the base of the cartridge and a latch to hold the cartridge in place.

To Hiram Percy Maxim and Roland B. Bourne, assignors to the Maxim Silencer Company, No. 1,756,297 covering special details of construction of a silencer.

To Rudolph Noske, No. 1,756,603, for a gun sight mounting. This mount is devised to facilitate adjustment and to hold the sight against accidental displacement.

To Charles J. Cook, No. 1,756,677 for a magazine and clip holder. The device consists of a stamped metal holder in which a magazine or clip filled with cartridges may be carried and from which they may be readily removed.

To Maj. James L. Hatcher, Ord. Dept., U. S. Army, Wright Field, Dayton, Ohio, No. 1,756,685 for a rear sight. The main object of this invention is the provision of a sight which may be mounted directly on the receiver of a firearm.

To Victor Bourth, No. 1,756,847 for an automatic pistol of the sliding breech-block type having a novel sear mechanism.

To Rudolph von Frommer, No. 1,758,486, for an automatic firearm designed so that the barrel may be quickly removed and replaced.

To Daniel N. Mink, No. 1,759,132, for a gun discharging means. This device consists of a rack reciprocated by the trigger to rotate a pinion upon the shaft of which is mounted a cam surface which cocks and releases the striker.

To Bethel-Abiel Revelli, assignor to Armamenti Militari S. A., No. 1,759,277 for an automatic firearm. The main object of this invention is the provision of a comparatively light breech bolt and means for firing a cartridge slightly in advance of complete closure of the breech bolt while the same is still moving forwardly.

To Robert Kauch and Charles L. Paulus, of Wright Field, No. 1,759,012 for a range finder and gun sight for aircraft guns.

To Donald A. Baker, assignor to J. Walter Fecker, No. 1,770,451 for a telescope-sight mounting. This invention relates more specifically to means for adjusting a sight.

To Thomas A. Watson, No. 1,770,445 for a sight for firearms which consists of a slender rod of nonreflecting material upon which is mounted a disc of reflecting material which is set at a slight angle to the vertical.

National (25) Track Tractors, built by National Brake & Electric Company, Milwaukee, Wisconsin, are equipped with Chrome Vanadium Steel in main drive shafts and highly-stressed bolts.

Main drive shaft of Chrome-Vanadium Steel, used in National (25) Track-Tractors.

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IN National (25) Track-Tractors, built by National Brake & Electric Company of Milwaukee, the main drive shafts transmit the power from the engine to the crawler axles. When the Track-Tractor is operating, the drive shafts are constantly subject to repeated and severe shocks and stresses.

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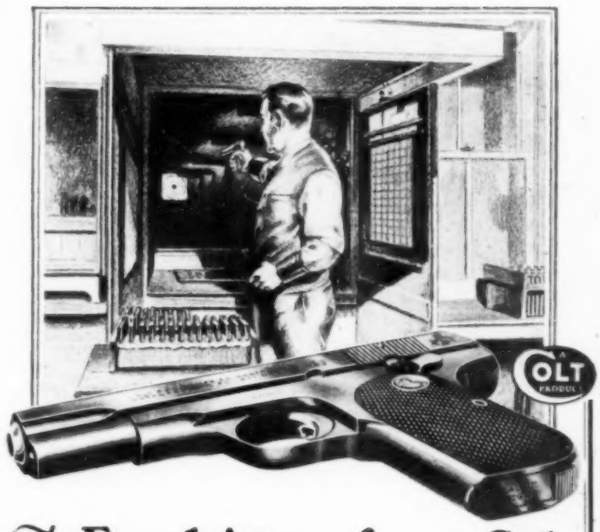

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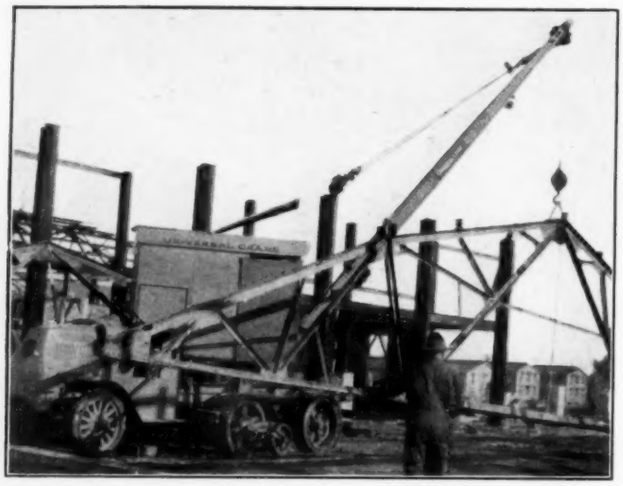

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Jersey City, N. J. Portsmouth, Va.
Meadville, Pa.

To Giuseppe Mascarucci, assignor to Safat Societa Anonima Fabrica Armitorino, No. 1,771,132, for a device for reducing the rate of fire of automatic firearms, having an escapement wheel in the mechanism for controlling the rate of action.

To Louis Beaujard, No. 1,772,066 for a control device for machine guns, in which electro-mechanical means are made use of to synchronize aircraft machine guns.

To Bethel Abiel Revelli, No. 1,772,227 for a four-barrel pistol. The hammer or striker has a revolvable head which is rotated one-fourth of a turn each time the hammer is cocked to bring the firing point successively into position to strike the priming caps of the cartridges.

To Capt. Richard C. Coupland, Office of the Chief of Ordnance, No. 1,772,826 for an ammunition feed box and belt for machine guns. This is an expendable ammunition box in which the cover is torn away when the tab for feeding the belt into the machine gun is pulled over to position for insertion in the feed way.

To William R. Bluehdorn, Office of the Chief of Ordnance, No. 1,773,090 for a mount for machine guns which provides an easily transportable and steady mount.

To Cesare Soncini, assignor to Societa Italiana Ernesto Breda Per Construzioni Meccaniche, No. 1,773,441 for a machine gun and other automatic firearms. The invention covers specific details in the operating mechanism of the weapon.

To Zygmunt Wilman, No. 1,773,443, for the manufacture of silencer or exhaust tanks for machine guns and other automatic arms. This invention is another form of muzzle attachment provided with shutters for closing the exit from the attachment chamber.

To Quinton D. Foster, No. 1,774,053, for a rifle sight which consists of an elongated tube having peep holes toward the rear and an apertured diaphram toward the front.

To John W. Miller, assignor to Harry Clavir, No. 1,776,816, for a marksmanship-indicating apparatus. This device is a somewhat complicated mechanism upon which a rifle may be mounted and which indicates the actions of the party firing the rifle.

To Edgar A. Williams, No. 1,759,772, for a rifle barrel attachment and ammunition for shotgun barrels which provides an especially formed rifle barrel adapted to be inserted in a shotgun barrel.

To Thomas A. Watson, No. 1,760,389, for a specific form of mounting for sights.

To Edgar A. Williams, No. 1,760,731 for an interchangeable barrel for guns. The invention provides a special form of rifle barrel which may replace the usual shotgun barrel in a single barrel shotgun.

To Zygmunt Wilman, No. 1,763,286, for a damping or absorbing device for firearms for the prevention of sounds, flames and recoil. The device consists of a muzzle attachment having a gas chamber in which there is a shutter for automatically closing the exit from the chamber.

Also to Mr. Wilman, No. 1,763,287, for a similar device, having a somewhat differently constructed shutter.

To Oliver H. Loomis, assignor to Remington Arms Company, Inc., No. 1,763,665 for the provision of an improved form of action bar-locking device in firearms.

To Crawford C. Loomis, assignor to Remington Arms Company, Inc., No. 1,763,714 for an invention which relates

more specifically to magazine type shotguns and to improvements in the operating mechanism of such guns.

To Captain Coupland, of the Office of the Chief of Ordnance, No. 1,770,125, for a synchronized control system for machine guns. This novel control system is one which is adapted to be designed for hydraulic or electrical operation.

To Fritz Herlach, assignor to Rehinische Metallwaaren-Und Maschinenfabrik, No. 1,770,135 for an automatic firearm with sliding barrel and locked breech. In this device a two-part breech bolt is provided in which the forward or locking part during locking and unlocking movement rotates independently of the rear part of the bolt but is locked to the rear part of the bolt during the remainder of the bolt's reciprocatory movement.

To Maj. James L. Hatcher, Wright Field, Dayton, Ohio, No. 1,770,471 for a muzzle attachment for guns. This attachment is in the nature of a flash hider and recoil check and also prevents elevation of the muzzle of the gun due to discharge.

To Arno R. Scherf, No. 1,777,771, for a specific form of rifling grooves.

To Maurice de Boigne, assignor to Societe Anonyme Des Anciene, No. 1,778,626, for a tripod mounting for firearms. This invention consists of a tripod having a special attachment for mounting the gun for antiaircraft fire.

To John W. Harrington, assignor to Harrington & Richardson Arms Company, No. 1,779,770, for a collapsible firearm and relates to a specific form of joint between the barrel and receiver of a collapsible weapon.

To Oscar A. Ross, No. 1,782,148, for a synchronized machine gun. In this instance special cartridges not provided with the usual percussion cap are employed and are fired by a high tension spark.

TO Alfred F. Teitscheid, Picatinny Arsenal, No. 1,755,279 for a combination fuze. This fuze embodies a novel and safe means for holding a firing pin in unarmed position.

To Joseph D. McNutt, assignor to the Winchester Repeating Arms Company, No. 1,755,330 for a priming mixture of the noncorrosive type which contains mercury fulminate, barium nitrate, lead thiocyanate, and diphenylamin.

To George J. J. Clark and Ernest B. Jones, assignors to National Fireworks, Inc., No. 1,755,388 for an aerial flare. This is a parachute-carrying flare in which there is provided specific means for igniting the flare through the relatively more rapid motion of the flare than the parachute. The same parties have also been granted patent No. 1,755,389 covering specific features of the same structure.

To Robert J. Anderson, assignor to National Fireworks, Inc., No. 1,756,079 for a mortar shell in which expulsion of the shell and the base from the mortar is assured.

To Capt. S. P. Meek, Ord. Dept., U. S. A., Benicia Arsenal, No. 1,755,255 for a tracer mixture in which is included a salt of mercury.

To Anton Erik Andelin, assignor to Finska Forcit-Dynamit Aktiebolaget, No. 1,756,328 for a method and apparatus for forming plastic explosives into strings. This apparatus makes use of rollers provided with grooves between which the explosives are drawn to form the same into desired form.

To James B. Henderson, No. 1,757,800 for a ballistic apparatus for measuring the flight-resistance of a projectile.

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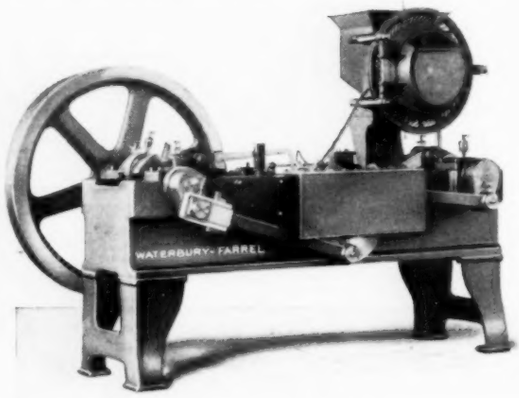

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Book Reviews

IT MIGHT HAVE BEEN LOST. By Thomas Clement Lonergan, New York: G. P. Putnam's Sons.

THIS first analysis of the records which concerned the entrance of the American Army into the theatre of war in France in 1917 does present a picture of the raw facts as they came from the nervous lips and pens of harassed and uncomfortable leaders. Some of them are no doubt very much embarrassed at these late revelations of their petty faults and of their unfulfilled and perhaps improper schemes. After all, they may have had good reason on their side, not only to be nervous, but to be scheming. One does not condemn all those who were selfish about their armies and their countries. And then so many of them have now passed out of reach and out of danger of rebuttal.

Thomas Lonergan has had exceptional opportunities to examine the available war records in England, France and America. From them he has excerpted short parts to substantiate the points he desires to make. They are: (a) An American army ought to have been formed, as General Pershing insisted against much opposition; (b) A supreme commander ought to have been selected and supported, as General Pershing advocated; (c) The American Army under its own commander, by breaking off the St. Mihiel salient, gave to its allies a splendid assurance of power and initiative that had much to do with the ultimate victory.

In his interesting account of the events, clustering about these three ideas, the author draws an intimate picture of the war, a picture worth looking at carefully. It is possible and even probable that American troops may again sleep on their arms in the fields of Alsace. If so, they will have new generals to make the decisions, new allies perhaps to argue with and to convince. It would be wise to put in the library a copy of Lonergan's book, marked at particular pages. If the English are to be met, one should then turn to pages so and so. If it be a French argument, see pages so and so. Or if the question be raised as to the proper selection of a supreme chief, well, the captains and lieutenants ought to be prepared.

STRATEGY IN HANDLING PEOPLE. By Ewing T. Webb and John J. B. Morgan. Chicago: Boulton, Pierce and Company. 1930. $3.00.

THIS book is the result of the collaboration of a business man and a psychologist. The authors believe that a study of what well known men have done in acquiring poise and power in their dealings with others can serve the reader as models. The sermons, then, consist of hundreds of sprightly anecdotes about famous men, and the lessons to be drawn are found at the conclusion of each chapter. Throughout the book the psychological basis for the success of particular attitudes or actions is explained. The book is entertaining and is of value in suggesting improved ways of dealing with the people with whom we come in daily contact.

VERDUN. By Henri Philippe Pétain, Marshal of France, Member of the French Academy. Authorized translation by Margaret MacVeagh. New York: The Dial Press. 1930. $4.00.

NEAR the close of the year 1915 Falkenhayn wrote: "France has almost arrived at the end of her military effort." His plan for winning the war was the method of attrition by attacking at a point "for the retention of which the French command would be compelled to throw in every man they have." Verdun was the point selected.

The refutation of this conception of potential victory was largely the result of Marshal Pétain's organizing ability and keen sense of tactical values. On February 21, 1916 the German Army commenced its attack on Verdun, and on the 25th Pétain took charge of the defense. Military history is the richer for this remarkably fine account of the terrific fighting that lasted on both sides of the Meuse for almost six months. The military student has reason to be grateful for this entirely fair and clear description of the turmoil of the early days, of the gradual development of organized defense out of the chaos caused by the German surprise attack, of the ultimate regaining by the French of their lost forts and territory. It is an outstanding contribution to the military history of the World War and reveals the author as successful with the pen as with the sword.

THE GODLIKE DANIEL. By Samuel Hopkins Adams, New York: Sears Publishing Co. 1930. $5.00.

THE complete writings of Daniel Webster were published in an 18-volume edition in 1903, and may be said to be the definitive edition. Curtis, in 1869, with his 2-volume work; Henry Cabot Lodge in *The American Statesman* series (both of a somewhat partial nature), and Fisher's defensive "True Daniel Webster" present the grandiose gentleman in full histrionic array. But neither these nor later biographers of Webster set for themselves the task of Samuel H. Adams who presents "not an exhaustive record nor an historical summary but an essay in portraiture."

Since Mr. Adams allows himself much latitude even to the construction of imaginative dialogue—which was an oratorical device of the godlike Daniel himself—we are constrained to believe that the portrait presented is more than overdrawn in many of its shadings. Few of Webster's undertakings are imputed a motive unattached from personal aggrandisement, and the pomposity of an oratorical style of another day is interpreted as applying to nearly every action of a long and rather fruitless public career. As lawyer, Congressman, Senator and Secretary of State, Webster has principally the negotiation of the Northeastern boundary to accredit to his career as a statesman. His lack of business judgment and good habit, his questionable financial transactions, his sponsorship of claims legislation for the inurement of his private law practice and his Bunker Hill and other orations must always deny to Webster the genuine. Rather was it action for personal gain and talk for talk's sake. This is the portrait Mr. Adams has drawn with the finesse of a Macaulay. It is a pen picture in the modern manner in that it is hypercritical of defects but not too generous of praise. Iconoclastic though it is, it will please the student of pre-Civil War days. It cannot, however, mar the technique of "sink or swim, survive or perish" and, after all, it is for the brilliance of peroration that Webster

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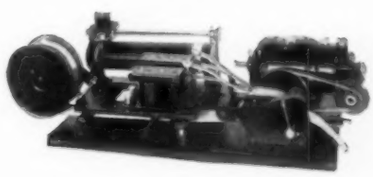

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is remembered and studied. He is an American colassus as an orator even though his statesmanship was fruitless, his manner grandiose and his personal affairs always in a muddle.

WHY YOU WIN OR LOSE, THE PSYCHOLOGY OF SPECULATION. By Fred C. Kelly. Boston: Houghton Mifflin Company. 1930. $2.00.

THE economist, the statistician and theorists of all kinds have taken their fling at the art of stock speculation. Their books are many and the readers of them (probably the authors, too) haven't grown visibly richer by following their precepts. So we approach this analysis by a psychologist with the hope that he may have something worth while to teach.

This little book, amusingly written, discusses speculation as a phenomenon of crowd psychology. It offers constructive suggestions which may be summarized as follows: "Buy stocks of companies that have shown gradually increasing earnings in essential industries; that is, industries making articles that people can't well do without; but don't buy, no matter how good the stocks are, until the whole market has definitely quit going down on bad news; then sell all your stocks when the market has ceased to advance on good news." The book should be read by prospective security buyers to learn how difficult it is to put this simple (?) rule into execution.

JEB STUART. By Capt. John W. Thomason, Jr., U. S. Marine Corps. New York: Charles Scribner's Sons. $5.00.

CAPTAIN Thomason is an officer of the United States Marine Corps and as the author of "Fix Bayonets," "Red Pants" and "Marines and Others" is already known to the readers of popular works. He has also written monographs for the War Department.

Stuart will always stand as a hero to the younger soldiers. He was killed when he was only thirty-one, yet he had risen to the rank of major general and was considered for the rank of lieutenant general to replace Jackson after he was killed. Gay, dashing, intoxicated with life, he rode in the front ranks and encouraged his men by his personal conduct. His handling of cavalry as security for the Army or on independent missions was bold and masterful. His ride around McClellan in the Peninsula, his raid on Chambersburg and his escape from Pleasanton and other United States' forces at White's Ferry, and his raid on York are described in detail. The absence of Stuart at Gettysburg until noon of the second day is discussed and excused as one of those things which happen although he had accomplished the mission given him when he was detached on June 25th. The book ends with an account of the campaigns in Virginia in 1864 until Yellow Tavern where on May 11th he received the wound from which he died.

The influence of supply on campaigns receives a proper share of attention in this book which is rare. References are made to the difficulties which beset the Confederacy in the matter of supply of ordnance. The accomplishments of General Gorgas, Chief of Ordnance, and one of his assistants, Colonel Rains, are described as miraculous. The Confederacy was better served in the matter of ordnance than in any other department, and shortages of the armies in the field were due to an inadequate system of supply and to

faulty distribution. (Perhaps we should read that statement again.)

Altogether this is a most readable book, written by an officer who writes with a military viewpoint yet with a charm that makes the book readable for all.

THE LIVES OF A BENGAL LANCER. By Francis Yeats-Brown. New York: The Viking Press. 1930. $2.75.

A BRITISH subaltern's pursuit of polo and pigs, philosophy and professional training on the northwest frontier of India before the World War sounds fairly commonplace. In reality, Francis Yeats-Brown makes an extraordinary adventure of it. First of all his regiment of Bengal cavalry is a most unusual military unit, and the country in which he serves is mysterious and fantastic. In the World War he serves in France and eventually in Mesopotamia as an air observer. There his plane is forced down, and he is a captive for long months in Turkey from which he finally escapes. Returned to India, it is evident that his rejoicing is sincere to be back in this country which has so deep a fascination for him. This outline of the author's career gives no inkling of the unique charm of the book, which has justly received the praise of literary critics both here and abroad.

PRE-WAR AMERICA. By Mark Sullivan. Volume III of Our Times—The United States, 1900-1925. New York: Charles Scribner's Sons. 1930. $5.00.

THIS latest volume of Mr. Sullivan's series, "Our Times," is devoted to the prewar period, the first quarter of the present century. It expands the discussion begun in "America Finding Herself" and so happily carried on in "The Turn of the Century." In this newest addition the men and events of the American panorama prior to the war are marshalled in fascinating array, in history as we remember it, the songs we sang, the heroes, the politics, the manners and customs, the men and women. Roosevelt, Rockefeller, Thaw, Cook and Peary, O. Henry, Taft, all of them and hundreds of others are here. And the things we did, the worries, the jokes, the inventions—*the times* themselves are brought back as only the pen and introspection of this internationally known correspondent can describe them.

Certainly no master hand could recount in more pleasing and informative fashion the national life of the American people just before the war. Here is history in its most captivating form, our own history as we have lived it. Thanks to the brilliant pen of Mr. Sullivan, we can relive it over and over again and not grow tired of it.

HANDBOOK OF ARMS AND ARMOR. By Bashford Dean. New York: The Metropolitan Museum of Art. 1930. $2.50.

THIS is the fourth edition of the Metropolitan Museum's handbook on European and Oriental arms and armor with an added chapter on the Bashford Dean Memorial Gallery by Stephen V. Grancsay. The collection of the Metropolitan Museum is second to none in illustrating the general subject of ancient weapons and, while the handbook is essentially a guide to the collection, it is in itself a chronological treatise on the types and development of instruments of defense, beginning with the earliest.

It will be sufficient to indicate the scope of descriptive

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matter to mention that generic and specific treatment is given the arms and armor of the Bronze Age and classical antiquity; the early centuries of the Christian Era; chain mail and Mediaeval armor, the period of transition from chain to plate armor and the periods of plate armor and of firearms. There are, also, discussions of the weight and size of armor, and of the Arab, Turkish, Persian, Indian and Japanese weapons. There are some two hundred excellent illustrations which, with the well prepared text, constitute an indispensable record for every student of armament.

American Fighters in the Foreign Legion, 1914-1918. By Paul Ayres Rockwell. New York: Houghton Mifflin Company, 1930. $5.00.

ANOTHER reviewer of this volume has said, "When I read this book I heard bands play. It made the old shivers run up and down my spine."

Of the fourscore and ten American volunteers who served honorably at the front in France in the ranks of the Foreign Legion, thirty-eight were killed in action or died of wounds. Most of the survivors were wounded from one to four times. Eight were decorated with the Cross of the Legion of Honor, twenty-one with the Medaille Militaire, and fifty-two with the Croix de Guerre. The little band of fighters won over one hundred citations in the Orders of the Day. Six of them became officers in the French Army, and ten received commissions in the American Army after the United States came into the war; two were Lieutenant-Colonels and two Majors at the end of 1918. Here is a record to go down with Thermopylae, a record of heroism and human interest that time will make even more glorious.

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